THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XVII.—*On Deep Sea Soundings;* by Prof. W. P. TROWBRIDGE, Assistant U. S. Coast Survey. Report to Prof. A. D. BACHE, Superintendent U. S. Coast Survey.

Published in this Journal by permission of the Department.

TO PROF. A. D. BACHE, SUPT. U. S. COAST SURVEY.

Dear Sir.—On receiving directions from you to examine the deep-sea soundings of Lieut. Comm. Joseph Dayman, R. N., along the line previously explored by Lieut. Com. Berryman, I took advantage of your suggestions and made an investigation of the laws of motion of the sounding weight and line used in deep-sea soundings. This seemed to offer the best mode of arriving at correct conclusions with regard to the probable errors of the results generally obtained by the methods employed, by which means only the values of the results can be determined, and comparisons of different results made.

Having had opportunities of consulting with you from time to time, I have been enabled to follow out your suggestions more satisfactorily than I could otherwise have done.

The substance of the report, which I have the honor to submit herewith, was given by your kind permission at the late Meeting of the American Association, and I have prepared it in a form to be printed with the proceedings of the Association if you should think it advisable.

The conclusions to which the investigations lead seem to be briefly, as follows:

1st. The sounding weight reaches its maximum velocity within the first three seconds of time after the weight has reached the surface; this maximum varies with the form and specific gravity of the weight, being

16 feet per second for a 32 pound shot and 27 feet for a 95 pound weight, such as was used by Lieut. Com. Dayman.

2d. When the line begins to offer resistance to the motion, the velocity is rapidly diminished, becoming at the depth of 2000 fathoms only two or three feet per second, and at 3000 fathoms, still less.

3d. This diminution of velocity is due entirely to the resistance offered by the line, the resistance offered by the sinker being at the depth of 2000 fathoms only a fraction of a pound, while that of the lines amounts to nearly the whole weight of the sinker; the excess of the weight of the sinker being sufficient to impart a very small velocity to the line.

4th. The resistance upon the line varies, 1st as the square of the velocity, 2nd as the diameter of the line, 3d as the length of line immersed.

5th. The variations of gravity do not sensibly affect the rate of sinking.

6th. The variations of density do not increase the resistance at great depths, but it appears that bodies which are compressible will fall more rapidly at great depths than near the surface.

7th. The smallest line that can be used with safety will give rise to sufficient resistance to support nearly the whole weight of the heaviest sinker at considerable depths.

8th. The probable errors of results where the length of line paid out is taken as the depth, are so great that this method is the most unreliable for determining the depth.

9th. The method of ascertaining the depth by Massey's Indicator is the best that has been devised, provided the indicator be always used with the same line and weight. This method however has also been very unsatisfactory, giving large errors on account of the faulty construction of the machines used.

10th. The results of Lieut. Com. Dayman were obtained from the former method, those of Lieut. Com. Berryman by the Indicator, and therefore Berryman's results are undoubtedly nearer the truth than Dayman's, but from neither can the existence of a "plateau" between Newfoundland and Ireland be made out.

There is yet, it seems to me, nothing to show that the bottom of the sea presents features any different from the face of the country across any portion of our territory, except perhaps the highest mountain ranges. The Highlands of the Hudson, for instance, would be unnoticed in this "plateau."

11th. To obtain correct results, some improved method of registering the depths seems to be necessary, and I would respectfully suggest a modification of Mr. Saxton's Current Indicator to suit the circumstances of the case.

I would also beg leave to suggest the coiling of the line within a cylinder which is to be attached to the weight, so that the line will uncoil from the moving body. By this means the resistance due to the motion of the line in the water, will be avoided. If this be practicable, much greater depths may be reached, and the weight will descend through all depths with a rapid and uniform velocity.

The mode of registering the depth may be the same as heretofore used, with less liability to error, on account of the short time required for the apparatus to sink to the bottom.

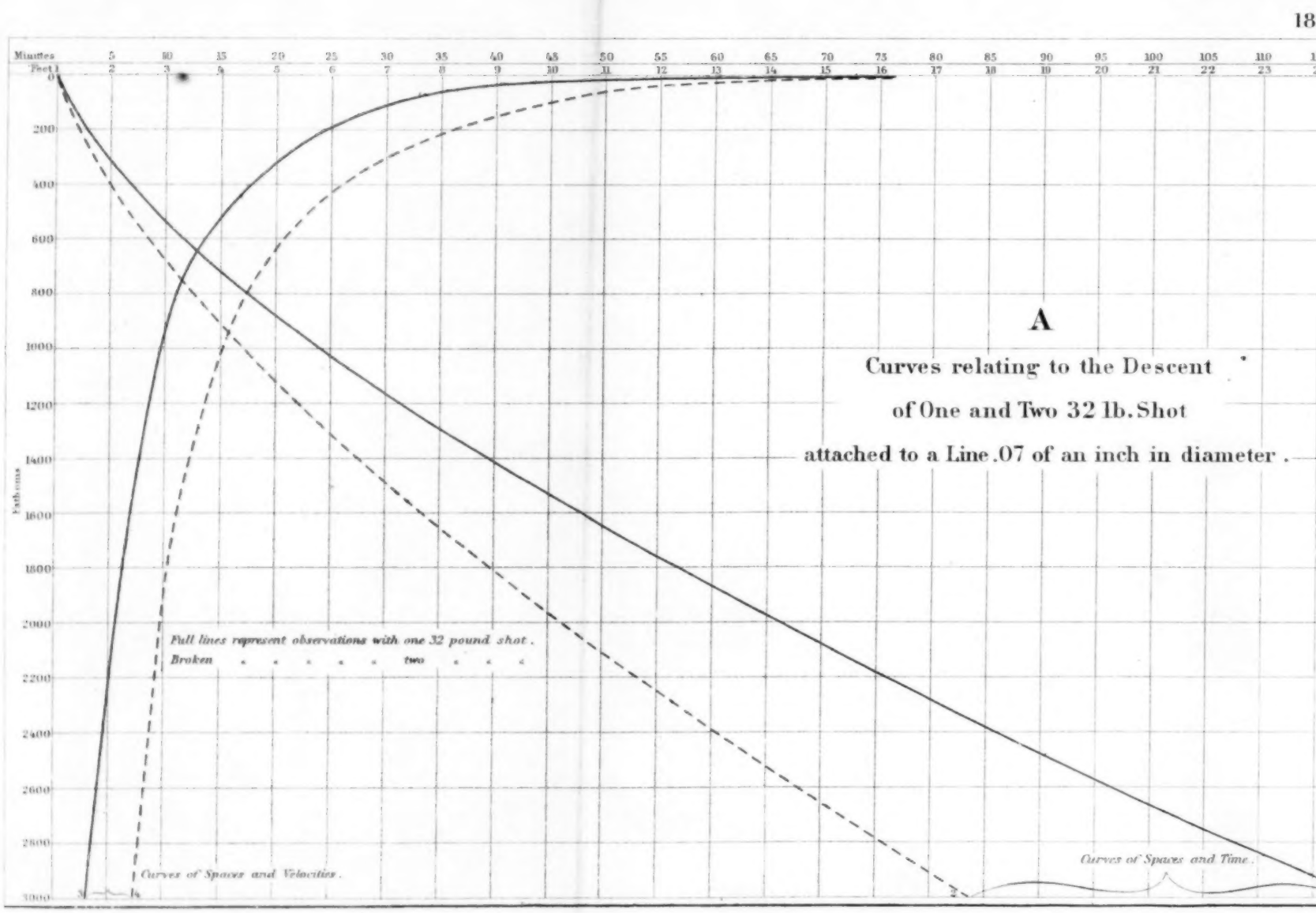
U.S. COAS

A.D. BACHE SU

CURVES ILLUSTRATING THE DESCEN

IN DEEP SEA

18


Minutes
Feet
Fathoms
A
Curves relating to the Descent
of One and Two 32 lb. Shot
attached to a Line .07 of an inch in diameter .
Full lines represent observations with one 32 pound shot .
Broken " " " " " two " " "
Curves of Spaces and Velocities .
Curves of Spaces and Time .

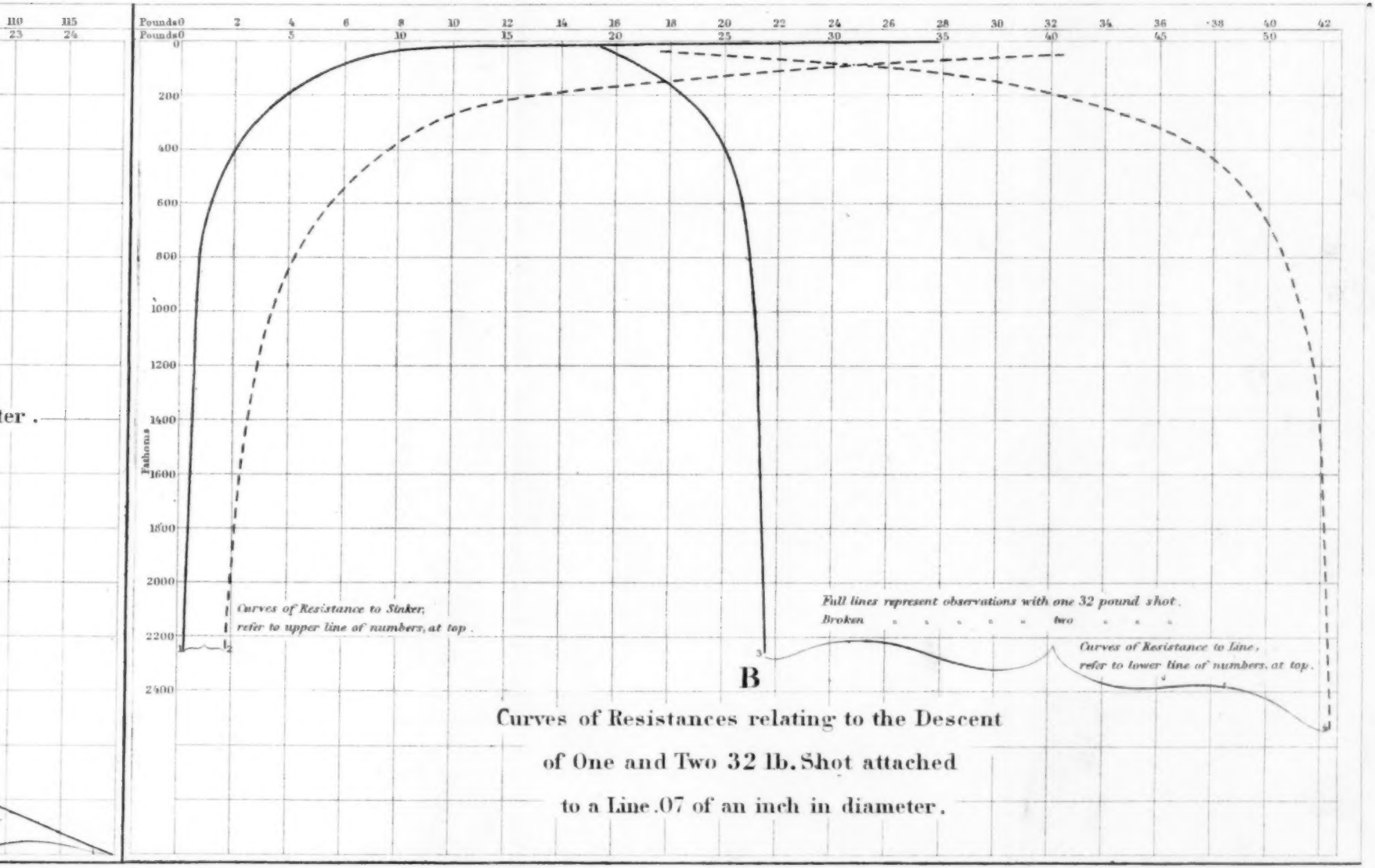
S. COAST SURVEY

CHE SUPERINTENDENT

SCENT OF THE SOUNDING WEIGHT AND LINE

P SEA SOUNDINGS

1858


110 115
23 24
Pounds 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
Pounds 0 5 10 15 20 25 30 35 40 45 50
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Fathoms
Curves of Resistance to Sinker, refer to upper line of numbers, at top.
Full lines represent observations with one 32 pound shot.
Broken " " " " " two " " "
Curves of Resistance to Line, refer to lower line of numbers, at top.
B

Curves of Resistances relating to the Descent of One and Two 32 lb. Shot attached to a Line .07 of an inch in diameter.

Where the time required for the weight and line to sink to the depth of 3000 fathoms is now one hour and a half, by the method proposed the apparatus might be made to sink to the same depth in fifteen or twenty minutes, and to smaller depths in proportionally less time.

Yours, very respectfully,

W. P. TROWBRIDGE,

Asst. U. S. Coast Survey.

Coast Survey Office, Washington, D. C., May 31st, 1858.

The explorations of the Gulf Stream by officers of our Navy, in connection with the survey of the coast, first gave rise to systematic efforts to determine sections of the bottom of the sea along continuous lines of great depth; afterwards, the extensive system of deep-sea soundings, executed under the direction of the Navy Department, through the exertions of Lieut. Maury, furnished most useful experience and results; and more recently the soundings along the line of the proposed Atlantic telegraph, first by Lieut. Commanding Berryman, U. S. Navy, and again by Lieut. Commanding Joseph Dayman, R. N., have shown that to reach the bottom of the sea is not beyond the power of human effort.

Notwithstanding so much has been done to overcome the practical difficulties which formerly embarrassed and discouraged any attemps to sound at great depths, it is undeniable that much uncertainty exists in the determinations that have been made, even where the depth is not greater than 2,000 fathoms; while below 2,000 or 2,500 fathoms, the errors and uncertainties amount to failures; and a limit has been reached beyond which it seems difficult to pass.

When the subject is viewed as a mechanical problem, it seems hardly possible, however, that insurmountable obstacles can exist to its practical solution. The facility with which an observer can place himself over any point, the distance of which below the plane on which he rests it is his object to determine, and from which he is separated by a medium freely and almost equally penetrable at all depths, the laws of which are well known, would seem to offer greater hopes of our being able ultimately to determine the depressions of the bottom of the ocean, by a greater number of observations and with greater accuracy, than the elevations of continents.

The solution of the question requires that the difficulties which have been found to exist in the present methods of sounding, should be clearly determined and overcome, and where these methods fail, that they should be improved if possible, or new ones substituted.

It will be seen on the least reflection that the difficulties are of a mechanical nature; not simply practical, for all that skill and experience can accomplish has been effected in overcoming the

practical difficulties which have been met in applying the ordinary methods; but the methods which are most naturally adopted for small depths fail when the depth is very great, on account of their inapplicability in the latter case.

It is important to separate those difficulties which may be overcome by skill and experience, from those which under the most favorable circumstances and conditions, are still as great as ever, and depend only upon the mechanical forces developed; and of course some proof will be required to show that the obstacles presented by the latter causes are, in the present mode of sounding, almost if not quite insurmountable.

If we suppose the water of the ocean to be in a state of rest, a sounding weight and line will descend according to the laws which govern the falling of heavy bodies in a resisting medium; the combined weight of the sinker and line, in the water, being the accelerating force, and the resistance offered by the water to the motion of the weight and line, the retarding force; and upon the relative magnitudes of these forces the circumstances of descent will depend.

The weight of the sinker and line in the water may be easily determined from their specific gravities, and for the purpose of determining the nature of the resistance upon these bodies, moving in the water, we have numerous experiments.

The experiments of Dubuat given in the "Principes d'Hydraulique," furnish data for determining the resistances to the motion of bodies whose forms and dimensions correspond to the sinkers generally used in sounding; and the numerous experiments in deep sea sounding, to which reference has been made, especially those of Lieutenants Lee and Berryman, U. S. Navy, afford the means of determining the resistance of the water upon the line.

In these latter experiments, the rate of descent was accurately observed and the results of numerous trials, with different weights attached to the same line, and with different lines, furnish the means of ascertaining the velocity of descent in each case, at every point of the path described by the falling body, with sufficient accuracy to determine all the circumstances of motion.

The problem then becomes one of the most simple in mechanics, viz.: having given the space, time, and velocity corresponding to the fall of a given weight in water, to find the law of resistance to the motion.

In some respects the problem is a new one. Although the resistances to the motion of any body, in water, under ordinary circumstances, are known to be proportional to the squares of the velocities, yet the experiments, from which this rule was deduced, were made upon bodies of certain regular forms, the

length of which, compared with the diameter of their cross section was not very great; and it will be at least interesting to know whether this law is true with reference to a line of great length and small diameter; and especially when this line is subjected to the great pressure which is exerted upon it in the depths of the ocean. The resistance in this case is entirely due to the velocity which is imparted to a certain quantity of water along the line, by its motion, and not to friction in the ordinary sense of the term. If the resistance from friction be at all considered, it must increase greatly with the depth, since the pressure is increased by fifteen pounds on every square-inch for every thirty four feet in depth. It will be seen by the subsequent discussion that the pressure has no influence in increasing the resistance.

Again, the density of the water at great depths, as affected by the compressibility of that fluid, must be considered, and also the variations of the force of gravity; which will of course depend upon the depth. These circumstances make the solution of the problem of interest, when considered in relation to the experiments which have been made upon the motion of bodies in water, under ordinary circumstances, at the surface of the earth; and the discussion of the subject should enable us to determine the best means of overcoming the difficulties which now exist in sounding to great depths.

The experiments of Lieutenants Lee and Berryman were made with one and two 32 pound shot, (iron) the line used being about seven hundredths of an inch in diameter, and capable of bearing a strain of 60 pounds; the weight of 100 fathoms, in air, being about 1 pound.

The mode of observing was as follows: several thousand fathoms of the line were coiled upon a reel of light construction, marks being first placed along the line at intervals of 100 fathoms; the end of the line was then attached to the weight, one or two thirty-two pound shot, as the case might be, and the shot dropped into the sea. The rate of descent was observed by noting the time of running out of each 100 fathoms, by a chronometer. The experiments were made from a boat, which was kept accurately over the descending line by the oars. In this manner the effects of the drifting of the boat in giving apparently a more rapid descent and a greater depth, was avoided, and although it is probable that in many instances the drift of the boat was considerable, yet the mean results of the experiments of Lieutenants Lee and Berryman from observations extending through several years, differ only by a small constant quantity which is inappreciable in the determination of velocities to the depth of 1000 fathoms; and below this the difference is still slight. I have therefore made use of the experiments of

Lieutenant Lee, which in some respects are preferable, (and which are sufficiently numerous to give good results,) rather than a mean of the results of Lee and Berryman.

The intervals of descent for one and two thirty-two pound shot are given in the table (I); the first column shows the depth in fathoms, the second the intervals of descent, in time, for each successive 100 fathoms.

The velocities are determined from these intervals by supposing the motion uniform during the running out of each one hundred fathoms, and dividing the space, in feet, by the time in seconds, which will give, very nearly, the velocity in feet at 50, 150, 250, &c. fathoms. The velocities at these points are given in the third columns under their respective heads.

It will be observed that the velocities of descent diminish, in the case of one 32-pound shot, from 8·83 feet per second at 50 fathoms, to 2·84 feet at 1000, and 2·09 feet at 2000 fathoms, and so on. And in the case of two 32-pound shot, from 12·50 feet per second at 50 fathoms, to 3·48 feet at 1000, and 2·99 feet at 2000.

The curves representing these circumstances of motion are given in diagrams marked (A), the vertical distances representing the spaces in fathoms and the horizontal distances for curves (1) and (2) representing intervals of time, and for curves (3) and (4) velocities in feet. Curves (1) and (2) therefore show the relation of the spaces and times, and curves (3) and (4) the relation of spaces and velocities. The curves in full lines are for one 32-pound shot, and those in broken lines for two 32-pound shot; the sounding line being the same in both cases. As these bodies have no initial velocity but start from rest at the surface, it is evident that the curves of velocity must pass through the origin (O), and as their velocities are already diminishing rapidly at 50 fathoms, it is interesting to determine the point of maximum velocity. For this purpose we must refer to the mathematical formulæ for the motion, which are well known. In case of a heavy body falling in water, the velocity expressed in terms of time, weight, density of medium, and form of body, is given by the following expression:

$$V=\sqrt{\frac{2g\,W}{S.D\,(m+q)}}\left(\frac{N-1}{N+1}\right)$$

in which (g) represents the force of gravity, (W) the weight of the body in water, (S) the area of the greatest cross section of the body, (D) the density of water, and ($m+q$) a constant determined by experiment; and, (the hyperbolic logarithm of N)

$$=\frac{t}{P}\sqrt{2g\,W.S.D\,(m+q)}.$$

In this latter expression (P) represents the weight of the body in air, including also the weight of the fluid drawn along by the body; and (t) the time in seconds.

The velocity will increase as (t) increases, and will become constant when the factor $\frac{N-1}{N+1}$ becomes unity; and it is evident that when (t) becomes so great that N may be taken for $N-1$ and $N+1$, without sensible error, the velocity will have become nearly constant, and will be represented by

$$V=\sqrt{\frac{2gW}{S.D.(m+q)}}$$

In the case under consideration $g=32{\cdot}189$ (feet), $W=27{\cdot}38$ (pounds), the weight of a 32-pound iron shot in sea water, $S=0{\cdot}21$ (square feet), D represents the weight of one cubic foot of sea water $=64{\cdot}177$ (pounds), and $(m+q)$ as determined by Dubuat in the experiments given in the "Principe d'Hydraulique" for a sphere moving in water $=0{\cdot}5$. These constants substituted in the formula give for one 32-pound shot, falling freely in sea water.

$V=16{\cdot}21$ (feet per second) for the maximum velocity.

To find the space passed over, before this velocity is reached, we have this expression,

$$Z=\frac{2P}{S.D\,(m+q)}.\log\frac{N+1}{2\sqrt{N}},$$

or when $N+1$ may be taken for N this expression may be placed under the form

$$Z=\frac{2P}{S.D\,(m+q)}\left(\tfrac{1}{2}\frac{t}{P}\sqrt{2g\,W.S\,D\,(m+q)}-L.2\right).$$

The time which must elapse before N becomes so great that $N+1$ may be taken for it, may be determined from the expression

$$L.N=\frac{t}{P}\sqrt{2gW.S.D(m+q)}.$$

Substituting in this expression the values of the known quantities for a 32-pound shot we have

$$L.N=t.(3{\cdot}13)$$

For 1 second $L.N=3{\cdot}13$ and $N>10$; for 2 seconds $L.N=6{\cdot}26$ and $N=1000$ nearly; for 3 seconds $L.N=9{\cdot}39$ and $N=10{,}000$ nearly.

Thus at the end of the third second N becomes so great that $N+1$ may be taken for it, without sensible error, in determining the velocity and space; and the formula for the space gives for the first and second seconds, 1 sec. $Z=9{\cdot}11$ feet, 2 sec. $Z=25$ feet, nearly, and $16{\cdot}21$ (feet) for each second afterwards.

The velocity of the shot reaches its maximum therefore before the resistance of the line has any great effect in retarding its motion; that is, during the first two or three seconds. Two 32-pound shot placed side by side will of course fall in the same time, and will attain the same maximum velocity, and the value, 16·21 (feet) will be also the maximum for two 32-pound shot; when the resistance of the water upon the line is developed, however, the greater weight will have the greater power of overcoming this resistance, and its velocity will be retarded less than in the case of one 32-pound shot, and the curves representing the velocities will commence to diverge at the maximum point.

It will be seen from the curves that the velocities diminish very rapidly for the first three or four hundred fathoms, then more slowly, and in case the specific gravity of the line is nearly the same as that of water, the vertical OC will become tangent to the curve of velocity at an infinite distance; and will become sensibly tangent at the depth of a few thousand fathoms, or in other words, the velocity of the sounding weight will be almost entirely destroyed. If the line is much heavier than water, and incompressible, as in the case of a wire, the velocity will reach a minimum at a certain depth, generally less than 2000 fathoms and will afterward increase. Both of these cases have important bearings, as will be seen hereafter.

The velocities as determined from experiment, show but little diminution below 2000 fathoms; but the number of cases below that depth was much less than at smaller depths, and moreover the difficulty of determining the intervals correctly, below this depth, is very great; the action of currents on the line, the drift of the boat, &c., when three miles of line are out, would affect the determinations greatly, and it seems to be preferable to determine these lower velocities by induction: instead of finding a velocity of two feet at 3000 fathoms, the actual velocity as determined by the curve, will not be greater than one foot and a half.

The curves of velocities seem to approach nearer to the hyperbola than any other form.

The resistances which cause this diminution of velocity in the descent, are due entirely to the constant increase in the length of line, since as we have seen the resistance which would be due to the shot falling alone corresponds to a constant velocity of 16·41 feet; and as the velocity is diminished, the resistance to the shot is diminished. To separate the resistance upon the line from that due to the shot, and to find the amount of these forces in pounds, we have for the resistance upon the shot at any point

$$R = S.D(m+q)h,$$

(h) being the height due to the velocity; and if at any point of the path described the motion be supposed uniform, for one second, we shall have, calling (W) the weight of the shot and line in water, (R') the resistance upon the line, and (R) the resistance upon the shot or sinker

$$W-(R+R')=0,$$

that is, the resistance is equal to the weight. This is the simplest mode of considering the subject. If the inertia of the masses be taken into account, we must employ the expression

$$\int_b^a W\,dz-\int_b^a R\,dz-\int_b^a R'\,dz=\tfrac{1}{2}M(v^2-v'^2)$$

v and v' being the velocities at any two depths (a) and (b) and the first member representing the quantity of action of the accelerating and retarding forces.

The term $\frac{1}{2}M(v^2-v'^2)$ involves the resistance opposed by the inertia of the shot and line while the velocity is diminished from v to v', and the resistance opposed by the inertia of a quantity of line equal to the distance $(b-a)$ as it is drawn from the reel at rest, and a velocity v' imparted to it. If the distance $(b-a)$ equal unity, or one foot, v and v' may be considered equal, and the latter expression reduces to the first equation; and by finding the relation between the quantities in the first equation, at different points of the depth, the values of the forces at these points will become known, and their variation with the depth will be exhibited.

The expression $W-(R+R')=0$ or $W-(S.D(m+q)h-R')=0$ involves two variable quantities (g) the force of gravity and (D) the density of the water.

The variations of gravity within the external surface of the earth, supposing the density of water to be the mean density of the earth, are proportional to the distance from the centre of the earth, and if (g) represent the force of gravity at the surface, (g') the same force at the depth z, and (r) the radius of the earth, we shall have

$$g'=g\left(\frac{r-z}{r}\right)=g-g\frac{z}{r}$$

The equatorial radius in fathoms is equal to 3487266, and at the equator for a depth of 3000 fathoms we shall have

$$g'=g-g\,\frac{3000}{3487266},$$

the second term being only ·0004 of the force of gravity; but the density of the water is less than the mean density of the earth, and the force of gravity will therefore not diminish with the depth, but in a less ratio; so that the amount of diminution at 3000 fathoms will be less than ·0004 of the force; we may

therefore consider the force of gravity constant; and in reality its diminution due to depth will be less than its variation with the latitude on the surface.

The density of the water increases with the depth, according to the law of compressibility of water, and to find the variations of density with depth we must refer to the law of compressibility.

From a report of Mr. Schott it appears that the shortening of a column of water from the pressure due to 600 fathoms is two fathoms; or the cubical diminution is about ·0001 of volume for one atmosphere.

The density being inversely as the volumes, for a given weight, we shall have, supposing (D) to be the density at the surface, and (D') the density at the depth (z)

$$D' = D . \frac{1}{1 - \cdot 0001 . \frac{z}{33 \cdot 90}}.$$

From this expression we find the density at the surface equal 1·029, at 1000 fathoms 1·048, at 2000 fathoms 1·066, 3000 fathoms 1·084. This increase of density is too small to affect sensibly the buoyancy of the fluid, or the resistance to motion, when considered with reference to the quantities which we wish to determine.

The weight of a 32-pound shot, for instance, in water, at the surface will be

$$W = 32 - 32 . \frac{1 \cdot 029}{7 \cdot 2},$$

the numerator and denominator of the last term being the specific gravities, respectively, of water and cast iron.

At 3000 fathoms the weight of the shot would be

$$W = 32 - \frac{1 \cdot 084}{7 \cdot 2},$$

and we see that the variations fall within the range of the specific gravities of the different varieties of cast iron.

The variation as affecting the resistance to motion will be shown in the expression

$$R = S . D (m + q) h,$$

where it is impossible to determine $(m+q)$ or h within the range of variations of D. We may therefore regard all the quantities as constant, and known, in the expression

$$W - (S . D (m+q) . h .) - R' = 0,$$

except R' which represents the resistance upon the line, and may be determined from the equation.

If the specific gravity of the line be very different from that of water, we shall have

$$W = W \pm W' z,$$

in which ($W'z$) is the weight of that part of the line immersed; the plus sign being used when the line is heavier than water, and the minus sign when it is lighter; and (W') being the weight in water of one foot of line.

In the experiments with one and two 32-pound shot the specific gravity of the line is supposed to be the same as that of water, and it is only in case of a wire being used, or a hemp line of large diameter, that it is necessary to take the specific gravity into account. As we wish to determine the *laws* of the resistances and not their absolute quantities in pounds, except in general terms; these very small quantities may with propriety be neglected.

We may now find the values of R' at different depths in the cases under consideration, viz., the fall of one and two 32-pound shot attached to a small line.

For one 32-pound shot $W=27{\cdot}36$ pounds, and the values of $S.D(m+q)h.$ for the different velocities in the third column of the table may be calculated. At the maximum velocity there is practically no line attached, as the action of a few feet may be neglected, and the whole resistance will be equal to 27·36 pounds, or equal to the weight of the shot in water, which is determined also from the expression

$$V=\sqrt{\frac{2gW}{S.D(m+q)}},$$

from which $R=S.D(m+q)\frac{V^2}{2g}=W=27{\cdot}36$ pounds.

The resistances to the shot are given in the fifth column of the table, and the curve representing these resistances, in pounds, is given in diagrams marked (B) curve No. 1.

The values of $R'=W-S.D.(m+q)h.$ are given in the sixth column of table I.

It will be seen that the resistance to the shot diminishes very rapidly at first, and at the depth of 2000 fathoms it becomes only 0·5 of a pound, while the resistance upon the line increases with the depth, becoming at 2000 fathoms $27{\cdot}36-0{\cdot}5=26{\cdot}8$ pounds.

For two 32-pound shot with the same line the resistances at the maximum velocity will be 54·72 pounds, and at 2000 fathoms 1·97 pounds; the tension of the line in this case is, at 2000 fathoms, nearly equal to its bearing weight, which was only 60 pounds. How much farther would it have gone without breaking and thus *indicating bottom?*

The diagrams marked (B) represent the laws of the resistances to the sinker or shot and to the line, respectively. The curves in full lines relate to one 32-pound shot, and those in broken lines to two 32-pound shot. Curves (1) and (2) represent the resistance to the *shot*, in pounds, at depths 50, 150, 250, etc.

fathoms; the abscissæ representing pounds. Curves (3) and (4) represent the resistances to the *line* at corresponding depths.

Diagrams in every respect similar have been made for the descent of sinkers of 126 and 96 pounds, attached to the ordinary deep-sea line, which is about $\frac{4}{10}$ths of an inch in diameter, and also for weights of 35 and 96 pounds, attached to a silk line $\frac{1}{10}$th of an inch in diameter. These latter results were obtained from the observations of Lieutenant Commanding Joseph Dayman, who sounded across the Atlantic along the line proposed for the ocean telegraph, in the summer of 1857. The deductions from Lieutenant Dayman's experiments confirm those obtained from the observations of Lieutenants Lee and Berryman.

A glance at the tables or curves will show, 1st, that the velocity of a descending weight and line, even with the smallest line, diminishes very rapidly after it has attained its maximum, which always occurs very near the surface; 2d, that at the depth of about 2000 fathoms the velocity is hardly two feet per second; 3d, that at this point nearly the whole resistance is due to the line, the resistance to the sinker being only a fraction of a pound; 4th, the resistance upon the *line* increases with the depth, becoming nearly equal to the weight, at 2000 fathoms; 5th, comparing the resistance upon the line when attached to one 32-pound shot and two 32-pound shot, respectively, these resistances for the same depth, or length of line, seem to be proportional to the squares of the velocities. To determine whether this law be true, table V has been constructed, in which the ratios of the resistances in pounds at the same depth in the two cases, are compared with the squares of the velocities. The ratios agree very nearly, the means differing by only a small fraction.

In table IV the same result is obtained with a larger line, the deep-sea line, the moving weights being 126 and 96 pounds.

We may therefore conclude that for the same length of line moving with different velocities the resistances are proportional to the squares of the velocities.

To ascertain the law of variation with the length, I have taken those points in the two cases at which the velocities are the same, corresponding of course to different depths or lengths. The results are given in table III, where the ratios of the lengths are compared with the ratios of the resistances. From this table it appears that the resistances are directly proportional to the lengths.

That is, if R represent the resistance upon a given length, moving with a velocity V; the resistance upon double the length, moving with the same velocity, will be $2R$.

This does not appear to hold true for all depths, for if we take the differences between the lengths corresponding to the same

velocity, for different velocities, or what is the same thing, different depths, and compare these differences of length with the differences of resistances, the resistances appear to diminish with the depth. This is particularly the case with the deep sea line where a given pressure of the water will have a greater effect in diminishing the diameter. It would seem to be a result which ought to have been expected, viz.: that in case of compressible lines, the pressure of the water instead of increasing the resistance to motion, diminishes it, since the combined tension and pressure tend to diminish the diameter of the line; while, as we have seen the change of density is so small that no sensible increase of resistance to motion among the particles, is produced.

This fact I do not consider *conclusively* shown by the investigation, for although in the last two columns of tables VI, VIII the numbers expressing the ratios of resistances when compared with the ratios of the lengths, appear to diminish with the depth, yet from a want of knowledge of the diameter and specific gravity of the lines used, it is impossible to detect very slight variations in the resistances. The conclusion is a natural one, however, that the diameter of the line being diminished by the combined pressure and tension, the resistance will diminish with the depth.

The observations which I have discussed are not sufficiently numerous to determine with certainty the influence of increasing or diminishing the diameter of the line. Taking the deep sea line and the small line, seven hundredths of an inch in diameter, the resistances to the same length moving with the same velocity appear to be proportional to the diameter. Table (VII). The diameters were probably as 1 to 3 or 4, but the diameter of the deep sea line was not exactly given.

The resistance of the water upon a sounding line, may therefore be represented by the following expression,

$$R = (\text{constant}) \times \sqrt{S}.l.v^2,$$

in which S represents the cross section of the line, l the length, and v the velocity.

The constant must be determined by experiment.

From these results we are justified in drawing the following conclusions.

1st. The resistance to the sinker, forming such a small part of the whole resistance at great depths, its form is not a matter of importance. 2d. With regard to its weight; the effect of a heavier sinker is to increase the velocity during the first part of the motion, which develops a greater amount of resistance upon the line, requiring of course a stronger line: with the line used in the experiments with two 32-pound shot, the resistance became so great at the depth of 2000 fathoms, that a slight

addition to the velocity by means of a greater weight, would have broken the line; and this result generally attended all attempts to make very deep soundings with the line attached to three or four 32-pound shot. Thus increasing the weight requires a larger line and causes an increase of the resistance in the double ratio of the diameter of the line and the square of the increased velocity, the resulting velocity at great depths will therefore remain nearly the same; a result which is found in practice.

The experiments with one 32-pound shot attached to a small line, given above, probably involve the most favorable conditions, as far as regards the weight, form of weight, and diameter of the line.

3d. The uncertainty of knowing the exact instant of the weight striking the bottom, the effect of drift or currents, and the great loss of velocity in the descent, requiring so much time for a single cast, are therefore difficulties which cannot be overcome by this mode of sounding, and there is a limit at two or three thousand fathoms depth, beyond which, the method practically fails, and even at less depths large errors must enter into the results.

The effect of increasing the specific gravity of the line as in making use of wire, is unfavorable, since at a certain depth the weight of the wire alone must overcome the resistance offered by the water, and it would run out of its own weight. The depth at which this would occur for a wire $\frac{7}{160}$ of an inch in diameter is about 1700 fathoms; and for a wire $\frac{3}{160}$ of an inch in diameter, 400 fathoms.

The same difficulty occurs when a large hempen line is used; a line two inches in diameter of this material would run out of its own weight with a velocity of 3 feet per second at the depth of 1900 fathoms. An instance of this kind is given in the experiment of Lieut. Joseph Dayman, R. N., in sounding across the Atlantic in 1857.

Table No. IX gives the results of the experiment referred to; when the line was hauled in, 200 fathoms of it were coiled upon the sinker, the latter having struck bottom at 2200 fathoms.

The next consideration is the mode of noting or measuring the depth within the limits which are accessible. For this purpose several plans have been followed, none of which have been so successful that the degree of accuracy attained, or the probable error of the determination, might be estimated.

The most natural method is to measure the length of the line paid out. The errors arising from the drifting of the vessel, and currents acting upon a long length of line in the water, may in this case amount to as much as the depth, and the method has accordingly been rejected entirely, where there is any current or drift. Computing the depth from the time and rate of descent

is another mode which in the manner in which it has been applied, is unreliable; especially on account of the difficulty of noting the exact instant when the sinker strikes the bottom.

The most successful plan thus far is to attach a self registering indicator to the weight, the indicator being brought back to the surface and the weight detached at the bottom.

The indicator heretofore used is known as "Massey's Indicator" and although theoretically well adapted to the purpose to which it is applied, yet on account of faults in its construction, the results obtained by its use, at great depths, have not been satisfactory; and in fact are of little more value than the determinations by the length of line paid out. In the soundings across the Atlantic in 1857 Lieutenant Commanding Dayman rejects the determinations by the indicator after numerous experiments to ascertain what he called its "index errors." The difficulty seems to be in the small surface given to the helix, the great size of the axis upon which the helices are placed, the friction of the wheel-work and, generally, the clumsy construction of the machine which prevents the helix from revolving with equal facility at all velocities. The comparisons made by Lieutenant Dayman show that different machines attached to the same sounding weight will give very different indications, and the same machine will give different indications when attached to different weights, and different lines.

The "Current Indicator" invented by Mr. Joseph Saxton of the office of Weights and Measures might, by very slight modifications, be applied to the purpose of sounding, and would be, in every respect, superior to Massey's.

With all its imperfections however, Massey's indicator furnishes better results when carefully used, than the method of measuring the depth by the line out; and for this reason I think the soundings of Lieut. Berryman where he used the indicator, on the line of the Atlantic telegraph, are much nearer the truth than those of Lieut. Dayman.

In both cases the probable errors are very large, amounting in many instances, I think, to several hundred fathoms.

The idea of a "Plateau" existing between Newfoundland and Ireland is not warranted it seems to me by any observations that have yet been made. The range of errors may be as great as 500 fathoms, which would admit of the existence of a submarine mountain on this line, half as high as Mount Washington. A true section of the Atlantic can only be determined by improved modes of sounding, since from the preceding discussion we may be warranted in the conclusion that it is practically impossible to determine the greatest depths of the ocean by the methods now in use.

I.—*Table showing the rates of descent and resistances in pounds upon the sinker and line in sounding with one and two 32-pound shot, attached to a line ·07 of an inch in diameter.*

Depth Faths.	One 32-pound Shot.				Two 32-pound Shot.			
	No. of Casts.	Intervals of Times of Descent.	Velocity.	Resist. to Sinker.	No. of Casts.	Intervals of Times of Descent.	Velocity.	Resist. to Sinker.	Resist. to Line.
		Min. Sec.	Feet.	Pounds.		Min. Sec.	Feet.	Pounds.	Pounds.
0			16·41	27·36				54·72	
50			8·83	8·15	19·15		12·50	32·70	22·02
100		1 08				0 48			
150			6·66	4·64	22·72		9·40	18·49	36·23
200		1 30				1 04			
250			5·41	3·06	24·30		7·32	11·21	43·51
300	29	1 51			27	1 22			
350			4·65	2·26	25·10		6·45	8·70	46·02
400	29	2 09			28	1 38			
450			4·14	1·81	25·55		5·61	6·58	48·14
500	29	2 25			28	1 47			
550			3·77	1·50	25·86		5·36	6·01	48·71
600	29	2 39			28	1 52			
650			3·55	1·33	26·03		4·81	4·98	49·74
700	27	2 49			22	2 03			
750			3·37	1·20	26·16		4·76	4·85	49·87
800	26	2 58			18	2 06			
850			3·11	1·02	26·34		4·48	4·30	50·42
900	27	3 13			16	2 14			
950			2·94	·91	26·45		4·23	3·83	50·89
1000	26	3 24			16	2 22			
1050			2·84	·85	26·51		4·03	3·48	51·24
1100	22	3 31			16	2 29			
1150			2·66	·75	26·65		3·85	3·17	51·55
1200	21	3 45			14	2 36			
1250			2·66	·75	26·65		3·73	2·98	51·74
1300	19	3 45			11	2 41			
1350			2·53	·68	26·68		3·45	2·55	52·17
1400	18	3 57			11	2 54			
1450			2·43	·62	26·74		3·44	2·53	52·19
1500	19	4 07			11	2 56			
1550			2·37	·59	26·77		3·26	2·28	52·44
1600	17	4 13			10	3 04			
1650			2·31	·56	26·80		3·23	2·23	52·49
1700	17	4 20			8	3 06			
1750			2·25	·53	26·83		3·19	2·18	52·54
1800	17	4 26			7	3 08			
1850			2·21	·51	26·85		3·08	2·03	52·69
1900	15	4 31			7	3 15			
1950			2·15	·48	26·88		3·06	2·00	52·72
2000	12	4 39			5	3 16			
2050			2·09	·44	26·92		2·99	1·91	52·81
2100	8	4 47			5	3 21			
2150			2·08	·43	26·93		2·93	1·84	52·88
2200	6	4 48			3	3 25			
2250			2·04	·41	26·95		2·84	1·73	52·99
2300	5	4 54			2	3 31			
2350			1·91				2·83	1·71	53·01
2400	4	5 13			2	3 32			
2450			1·99				2·67	1·53	53·19
2500	4	5 01			2	3 45			
2550	*	*	2·03			*	2·69	1·55	53·17

* In every instance the invervals became irregular and unreliable below 2500 fathoms.

TABLE I. (Continued.)

Depth	One 32-pound Shot.					Two 32-pound Shot.				
	No. of Casts.	Intervals of Times of Descent.	Velocity.	Resist. to Sinker.	Resist. to Line.	No. of Casts.	Intervals of Times of Descent.	Velocity.	Resist. to Sinker.	Resist. to Line.
Faths.		Min. Sec.	Feet.	Pounds.	Pounds.		Min. Sec.	Feet.	Pounds.	Pounds.
2600	3	4 56				1	3 43			
2650			1·83							
2700	3	5 27								
2750			2·22							
2800	1	4 30								
2850			2·11							
2900	1	4 44								
2950			2·14							
3000	1	4 40								

II.—*Table showing the rates of descent and resistances in pounds upon the sinker and line in sounding with* 96 *and* 126 *pound weights attached to a deep-sea line, four tenths of an inch in diameter.*

Depth.	96 pound Weight. Deep Sea Line.				126 pound Weight. Deep Sea Line.			
	Intervals of Times of Descent.	Velocity.	Resist. to Sinker.	Resist. to Line.	Intervals of Times of Descent.	Velocity.	Resistance to Sinker.	Resistance to Line.
Fath's.	Min. Sec.	Feet.	Pounds.	Pounds.	Min. Sec.	Feet.	Pounds.	Pounds.
0		27·26	82·03			26·99	106·26	
50		11·54	14·39	67·64		13·93	29·24	80·02
100	0 52				0 43			
150		7·41	6·08	75·95		8·44	10·68	98·58
200	1 21				1 11			
250		5·94	3·91	78·12		6·82	6·97	102·29
300	1 41				1 28			
350		5·17	2·96	79·07		5·60	4·70	104·56
400	1 56				1 47			
450		4·69	2·44	79·59		5·31	4·29	104·97
500	2 08				1 53			
550		4·35	2·10	79·93		5·04	3·81	105·45
600	2 18				1 59			
650		4·11	1·87	80·16		4·89	3·59	105·67
700	2 26				2 05			
750		3·89	1·64	80·39		4·48	3·10	106·16
800	2 34				2 14			
850		3·73	1·54	80·49		3·98	2·38	106·88
900	2 41				2 31			
950		3·61	1·44	80·59		4·19	2·65	106·61
1000	2 46				2 23			
1050		3·47	1·33	80·70		3·98	2·38	106·88
1100	2 53				2 30			
1150		3·37	1·26	80·77		4·05	2·44	106·82
1200	2 58				2 28			
1250		3·33	1·23	80·80		3·92	2·29	106·97
1300	3 00				2 33			
1350		3·37	1·27	80·76		3·87	2·23	107·03
1400	2 58				2 35			
1450		3·24	1·17	80·86		3·61	1·94	107·32
1500	3 05				2 46			
1550		3·11	1·08	80·95		3·53	1·85	107·41
1600	3 13				2 50			
1650		3·00	1·00	81·03		3·41	1·72	107·54
1700	3 16				2 56			

TABLE II. (Continued.)

Depth.	96 pound Weight. Deep Sea Line.				126 pound Weight. Deep Sea Line.			
	Intervals of Times of Descent.	Velocity.	Resist. to Sinker.	Resist. to Line.	Intervals of Times of Descent.	Velocity	Resistance to Sinker.	Resistance to Line.
Fath's.	Min. Sec.	Feet.	Pounds.	Pounds.	Min. Sec.	Feet.	Pounds.	Pounds.
1750		2·90	·93	81·10				
1800	3 16							
1850		2·80	·87	81·16				
1900	3 27							
1950		2·70	·81	81·22				
2000	3 43							
2050		2·70	·81	81·22				
2100	3 43							
2150		2·47	·68	81·35				
2200	4 03							

III.—*Table showing influence of different lengths of line moving with the same velocity. Ratios of length to ratio of resistances.*

Velocity.	Depth.		R.	R'	Ratio of Lengths.	$\frac{R'}{R}$	Depth.		R	R'	Ratio of Lengths.	$\frac{R'}{R}$
	1 32-lb. Shot.	2 32-lb. Shot.	1 32-lb. Shot.	2 32-lb. Shot.			96-lb. Weight.	126-lb. Weight.	96-lb. Weight.	126-lb. Weight.		
Feet.	Fath.	Faths.	P'nds.	P'nds.			Fath's.	Fath's.	P'nds.	Pounds.		
8·	70	200			2·857		120	175			1·458	
7·5	100	220			2·200		140	200	71·6	96·8	1·428	1·352
7·	120	280			2·325		170	240	73·8	100·0	1·411	1·355
6·5	150	340	21·7	47·6	2·266	2·193	200	280	75·2	101·5	1·400	1·350
6·	190	420	23·2	48·5	2·211	2·090	240	330	76·6	102·7	1·375	1·341
5·5	230	510	24·5	49·3	2·217	2·012	300	400	77·8	103·9	1·333	1·336
5·	290	640	25·7	50·0	2·206	1·945	380	500	78·8	104·9	1·315	1·331
4·5	350	820	26·7	50·8	2·342	1·902	520	660	79·6	105·7	1·269	1·328
4·	480	1080	28·2	51·8	2·250	1·837	710	880	80·2	106·5	1·239	1·328
3·5	650	1400	29·7	52·4	2·153	1·764	1080	1340	80·7	107·2	1·240	1·328
3·	880	1900	31·3		2·159		1650		81·2			

IV.—*Table showing velocities and resistances at different depths and comparison of squares of velocities to resistances. Observations made with 96 and 126-pound weights. Deep-sea line.*

Depth.	96-lb. Weight.		126-lb. Weight.		Ratios of Squares of Velocities.	Ratios of Resistances to Lines.
	Velocity.	Resistance to Line.	Velocity.	Resistance to Line.		
Fathoms.	Feet.	Pounds.	Feet.	Pounds.		
0	27·26		26·99			
50	11·54	67·64	13·93	80·02	1·457	1·183
150	7·41	75·95	8·44	98·58	1·297	1·298
250	5·94	78·12	6·82	102·29	1·318	1·310
350	5·17	79·07	5·60	104·56	1·173	1·322
450	4·69	79·59	5·31	104·97	1·282	1·319
550	4·35	79·93	5·04	105·45	1·342	1·319
650	4·11	80·16	4·89	105·67	1·414	1·318
750	3·89	80·39	4·48	106·16	1·326	1·321
850	3·73	80·49	3·98	106·88	1·138	1·328
950	3·61	80·59	4·19	106·61	1·347	1·323
1050	3·47	80·70	3·98	106·88	1·316	1·325
1150	3·37	80·77	4·05	106·82	1·444	1·322

V.—*Table showing velocities and resistances at different depths and comparison of squares of velocities to resistances. Observations made with one and two 32-pound shot. Small line.*

Depth.	One 32-pound Shot.		Two 32-pound Shot.		Ratios of Squares of Velocities.	Ratios of Resistances to Lines.
	Velocity.	Resistance to Line.	Velocity.	Resistance to Line.		
Fathoms.	Feet.	Pounds.	Feet.	Pounds.		
0	16·41		16·41		1·000	
50	8·83	19·15	12·50	22·02	2·004	1·150
150	6·66	22·72	9·40	36·23	1·992	1·595
250	5·41	24·30	7·32	43·51	1·831	1·790
350	4·65	25·10	6·45	46·02	1·924	1·833
450	4·14	25·55	5·61	48·14	1·843	1·884
550	3·77	25·81	5·36	48·71	2·021	1·887
650	3·55	26·03	4·88	49·74	1·890	1·911
750	3·37	26·16	4·76	49·87	1·995	1·906
850	3·11	26·34	4·48	50·42	2·084	1·914
950	2·94	26·45	4·23	50·89	2·070	1·924
1050	2·84	26·51	4·03	51·24	2·014	1·933
1150	2·66	26·65	3·85	51·55	2·095	1·934
1250	2·66	36·65	3·73	51·74	1·966	1·941
1350	2·53	26·68	3·45	52·17	1·859	1·911
1450	2·43	26·74	3·44	52·19	2·004	1·907
1550	2·37	26·77	3·26	52·44	1·892	1·914

VI.—*Table showing influence of lengths at different depths.*

Velocity.	Depth.		Diff.	$R'-R$	R	Ratio of Lengths.	Ratio of Resistances.	Depth.		Diff.	$R'-R$	R	Ratio of Lengths.	Ratio of Resistances.
	1 32-lb. Shot.	2 32-lb. Shot.						96-lb. Weight.	126-lb. Weight.					
Feet	Fath.	Fath.	Fath.	Pounds	P'ds.			Fath.	Fath.	Fath.	Pounds	P'ds.		
8·	70	200						120	175					
7·5	100	220						140	200		25·2	71·6		2·841
7·	120	280						170	240		26·2	73·8		2·817
6·5	150	340	190	25·9	21·7			200	280	80	26·3	75·2	2·50	2·859
6·	190	420	230	25·3	23·2	1·211	1·090	240	330	90	26·1	76·6	2·66	2·938
5·5	230	510	280	24·8	24·5	1·217	1·012	300	400	100	26·1	77·8	3·00	2·981
5·	290	640	350	25·3	25·7	1·207	0·984	380	500	120	26·1	78·8	3·17	3·019
4·5	350	820	470	24·1	26·7	1·343	0·903	520	660	140	26·1	79·6	3·71	3·049
4·	480	1080	600	23·6	28·2	1·250	0·837	710	880	170	26·3	80·2	4·18	3·072
3·5	650	1400	750	22·7	29·7		0·764	1080	1340	260	26·5	80·7	4·16	3·045
3·	880	1900	1020		31·3			1650				81·2		

VII.—*Comparison of resistances upon the same lengths of lines of different diameters, moving at the same velocity.*

Velocity.	Deep Sea Line.			Small Line.		
	Depth. 96 lb. Weight.	*R.*	Resistance upon one Fathom.	Depth. 1 32-lb. Shot.	*R.*	Resistance upon one Fathom.
Feet.	Fathoms.	Pounds.	Pounds.	Fathoms.	Pounds.	Pounds.
8·	120			70		
7·5	140	71·6		100		
7·	170	73·8		120		
6·5	200	75·2	0·3765	150	21·7	0·144
6·	240	76·6	0·3191	190	23·2	0·122
5·5	300	77·8	0·2593	230	24·5	0·106
5·	380	78·8	0·2073	290	25·7	0·088
4·5	520	79·6	0·1530	350	26·7	0·076
4·	710	80·2	0·1129	480	28·2	0·058
3·5	1080	80·7	0·0747	650	29·7	0·045
3·	1650	81·2	0·0492	880	31·3	0·035

VIII.—*Table showing influence of lengths at different depths.*

Velocity.	Depth. 1 32-lb. Shot.	Depth. 2 32-lb. Shot.	Diff.	$R'-R$	R'	Ratio of Lengths.	Ratio of Resistances.	Depth. 96-lb. Weight.	Depth. 126-lb. Weight.	Diff.	$R'-R$	R'	Ratio of Lengths.	Ratio of Resistances.
Feet	Fath.	Fath	Fath.	Pounds	P'ds.			Fath.	Fath.	Fath.	Pounds	P'nds.		
8·	70	200						120	175					
7·5	100	220						140	200			96·8		
7·	120	280						170	240			100·0		
6·5	150	340	190	25·9	47·6	1·789	1·838	200	280	80	26·2	101·5	3·500	3·874
6·	190	420	230	25·3	48·5	1·826	1·917	240	330	90	26·1	102·7	3·666	3·935
5·5	230	510	280	24·8	49·3	1·821	1·988	300	400	100	26·1	103·9	4·000	3·981
5·	290	640	350	25·3	50·0	1·829	1·976	380	500	120	26·3	104·9	4·166	3·988
4·5	350	820	470	24·1	50·8	1·745	2·108	520	660	140	26·1	105·7	4·714	4·049
4·	480	1080	600	33·6	51·8	1·800	2·195	710	880	170	26·3	106·5	5·176	4·049
3·5	650	1400	750	22·7	52·4	1·866	2·308	1080	1340	260	26·3	107·2	5·154	4·076
3·	880	1900	1020					1650						

IX.—*Table showing the rates of descent, velocity, resistance to sinker and line, and weight of line in water, from observations made by Lieut. Comm. Joseph Dayman, R. N. Diameter of line 2 inches. Specific gravity 1·3. Weight 96 pounds.*

Depth.	Intervals of Times of Descent.	Velocity.	Resistance to Sinker.	Resistance to Line.	Weight of Line in Water.
Fathoms.	Min. Sec.	Feet.	Pounds.	Pounds.	Pounds
0		27·26	82·0		
100	1 24	7·14	5·62	100·6	23
200	1 17	4·35	4·33	119·4	46
300	2 01	.....	4·33	138·1	69
400	2 07	.....	.....	156·8	92
500	2 20	.....	.....	175·5	115
600	2 18	.....	.....	194·2	138
700	.....	.....	.....	212·9	161
800	.....	.....	.....	231·6	184
900	.....	.....	.....	250·3	207

TABLE IX. (Continued.)

Depth.	Intervals of Times of Descent.	Velocity.	Resistance to Sinker.	Resistance to Line.	Weight of Line in Water.
Fathoms.	Min. Sec.	Feet.	Pounds.	Pounds.	Pounds.
1000	.....	.....	.....	269·0	230
1100	.....	.....	.....	287·7	253
1200	.....	.....	.....	296·4	276
1300	.....	.....	.....	325·1	299
1400	.....	.....	.....	343·8	322
1500	.....	.....	.....	362·5	345
1600	.....	.....	.....	381·2	368
1700	.....	.....	.....	399·9	391
1800	.....	.....	.....	418·6	414
1900	.....	.....	.....	437·3	437

ART. XVIII.—*On an Earthquake in Western New York;* by C. E. WEST.

AN earthquake was felt in Western New York, on the 23d of October last. The following pages contain such statistics respecting it, as have come to my knowledge.

It occurred in Buffalo, at a quarter past 3 o'clock, P. M., and was violent, compared with other earthquakes in the Northern States. I was seated in a chair with my head leaning against the mantle of the fireplace, when the shock occurred, and so great was its violence, as to throw me forward to my feet. My first impression was that the chimney had fallen. I hastened into the street to see if that were the case, and found that others had left their houses for a similar reason. A young lady belonging to my family was standing by the wall of the rotunda—which is built of stone and is some sixty feet high,—and so strong was her impression that the wall was falling, she rushed out of the place in great fear.

The principal of one of our public schools informs me, that he was in the third story of the school house at the time; that the walls vibrated for a minute, and that the vibration increased and diminished, then increased and diminished. The supreme court of the city was in session, and so great was the alarm produced by the shock that most of the persons in attendance left in great haste. A mechanic who was present said that the walls swayed four inches from a vertical line. A person walking in the street remarked that the noise produced by the shock seemed to him like the dumping of coal upon the pavement. Another resident of the city said the roar seemed as though it were produced by a multitude of carriages rapidly driven under ground. It appeared to him to come from the northeast and pass to the southwest.

Many examples of a similar character might be given to show the nature of this earthquake, as experienced by the inhabitants of Buffalo, but sufficient have been cited for our purpose. Houses were shaken, door bells were rung, crockery rattled upon the shelves, the people were alarmed.

I have received communications from persons living in neighboring towns, which will aid us in tracing the character and extent of the earthquake wave. The shock was generally severe throughout this county. Farmers at work in the fields were much alarmed. An interesting fact is related of a farmer living in Aurora, a town 16 miles S.E. of Buffalo. He was digging potatoes in his field, at the time of the earthquake, and so powerful was the shock, that he instinctively leaned upon his hoe-handle, and while in this posture, he observed the dirt shake back and forth over the top of the hoe, which was partially buried in the soil.

J. Henning, Esq., editor of one of the Toronto, C. W. papers, writes, "In reply to your note of yesterday, enquiring respecting the supposed shock of an earthquake in Toronto on the 23d Oct. last, I may say, that I have been unable to find any one who felt such a shock. Indeed, I do not think that it came in the direction of this City; but extended in a line through Buffalo and the central portions of the State of New York. It is said that it was experienced sensibly in Hamilton, (C. W.) at 3 o'clock, P. M.; that there were two distinct shocks at intervals of ten seconds accompanied with a rumbling noise. This is possible; as it was also felt in another portion of the same ridge of hills at Queenstown. In Port Hope and Peterboro' it was felt, or I am inclined to think, fancied to be felt, by some parties. There was no mention of it in those places until after the account of its visit to Buffalo was published. After its tricks in the latter city, several other localities claimed the honor of a visit. I think on the whole, the Hamilton hills bounded its progress in our direction, still I may be in error."

Rev. Mr. Cook of Lewiston writes, "It occurred here at the same time as in Buffalo. The noise was very distinct, as of a train of cars; and the motion was such as to cause a perceptible undulation in our dwellings, and to make dishes and stoves rattle audibly. The same phenomena attended its appearance at about the same time at St. Catharines, twelve miles west of this."

Judge Dayton of Lockport, writes, "The earthquake on the 23d of Oct. was felt here very sensibly, though probably less so than at Buffalo. I was myself in the cars between Lockport and Niagara Falls at the time, and of course did not notice it. At the County Clerk's office in this village, it is said to have been preceded by a low rumbling noise not unlike the heavy rumbling of a train of cars approaching from a distance. The

sound came from the West; and as it approached increased, though still dull and heavy, and was accompanied with a perceptible motion of the walls of the building, a shaking of the windows, and a distinct vibratory motion was given to the chandeliers suspended in the office. The general impression seemed to be that the shock lasted about a minute, though there is nothing reliable in that particular. Probably the time was less than that, as there seems to have been no repetition of the shock. At my house which is a mile and a half distant, the observations made by my family were very similar to those made at the Clerk's office. There was a distinct rattling of the windows.

Some in the village described the noise as like that made by the echo following the discharge of a cannon. It is generally understood that it occurred a little after three o'clock in the afternoon. I can find no one, however, who was particular to note the time."

"At Pendleton about five miles southwest of this, the observations made were the same as at this place, in regard to the shock and its accompaniments. My informant says it occurred there precisely at 3 o'clock."

"It may not be amiss to state that we had another shock here in the early part of January (1858) about ten or eleven P. M. It was slighter than that in Oct., and was accompanied by the same dull, heavy, rumbling sound, and a perceptible shaking of windows, doors, &c. I was partly asleep at the time, but thoroughly aroused by the same."

Prof. Dewey of Rochester University, writes, "I have no information to give. The earthquake was distinct at Lockport about 3½ o'clock P. M. It was noticed at Medina I heard, and at Batavia, as well as at Brockport. It was said to have been noticed here, but I could not find any clear evidence of the fact."

The Principal of the Brockport Collegiate Institute, writes, "The shock of an earthquake was very sensibly felt here on the 23d of Oct. last by many persons."

Rev. Dr. Samuel H. Cox, Chancellor of Ingham University, at Leroy, N. Y., writes, "In relation to your inquiry touching the earthquake, said to have occurred in all this region, on Friday, Oct. 23d, 1857, I can only say, not from my own consciousness, or memory, but from the concurrent testimony of many others, that a sensible terra motus was realized here and in many other places, on that afternoon.

Several of the young ladies of the University, some then at houses in the vicinity, declare their sensations at the time, all taking notice of it. One of them says, 'I was at the piano playing alone. The shock made the windows rattle and was repeated after a few moments.'

A very intelligent lady in my immediate neighborhood told me distinctly as follows: 'I well recollect it, I was sewing quietly in my chamber, when the shaking of the house alarmed me; the windows rattled; the reality of it was certain. I descended to the kitchen and asked my cook if she knew what was the matter, she replied yes ma'am, it thundered.'

An educated and excellent friend of mine at Avon, near us, about 14 or 15 miles east by south of my residence says, 'yes, I felt it—I was reclining on my bed at the time. The whole house shook so alarmingly that I arose, went down and compared notes with others. We all felt it and recognized it as a veritable earthquake.'"

Rev. E. S. Wright of Fredonia, Chautauque Co., N. Y., 40 miles S.W. of Buffalo, writes, "the earthquake to which you allude, I should think, was felt in this village, about half past 3 o'clock on the 23d of Oct. last; at least, somewhere between fifteen and thirty minutes past three P. M. At the time, I was conversing with a deacon of my church, a short distance from the village, who was husking corn in his barn. The sound was a rumbling noise, approaching slowly and loudly like the heavy wheels of a loaded wagon, in the road. The noise continued about the length of time in which a wagon would be passing the barn pretty rapidly with a load. Mrs. Wright says she was aroused by a sudden noise as if my book-case had been struck by a person falling against it in a chair. Soon the house seemed to rise and sink a little, and all was over. The earthquake was felt similarly throughout the place, I believe."

Rev. Charles F. Massey, of Westfield, Chautauque Co., N. Y., 57 miles W.S.W. of Buffalo, informs me that the shock was felt in that village.

C. D. Sacket, Esq., Editor of the Jamestown Journal, Jamestown, Chautauque Co., N. Y., S.W. of Westfield, writes, "The shock of an earthquake was distinctly felt at this place and at Warren, Pa., (20 miles south) at 3 to 4 o'clock P. M. The character of the phenomenon was first a shock and then a vibration of the ground. Stoves and windows shook. My wife, on a visit at Westfield, N. Y., heard a sound, as if the cars were approaching the house, though the road was half a mile off. It was noticed by our citizens generally. Dr. Parker of the water-cure here, was reclining on a sofa, reading, when he felt a jar and heard a sound, as if some one had jumped from quite a height to the floor in the hall. The effect did not seem to continue more than a moment or two."

Rev. C. L. Hequembourg of Warren, Pa., a town situated on the Alleghany River, about 120 miles N.N.E. of Pittsburg, writes, "Several persons felt the shock here, and it was also felt at Sugar Grove, (15 miles N.W. of Warren). It was felt so slightly

here that very few facts could be ascertained in regard to its direction, &c. My impression is that the movement was from S.E. to N.W., perhaps the reverse. The time, if I recollect right, was a little earlier in the afternoon than you mention. The shock appears to be of a local character, confined to this region only. It is worthy of remark that the shock was preceded by a series of rains, such as had not been known before in this section of country for many years. I should think the movement was horizontal only, but as to whether it radiated, and where the centre was, I can give you no information. Perhaps it was altogether linear. . . . . When I felt the shock to which you refer, I was sitting in my study writing; I thought some one was moving violently upon the lower floor; but listening, found it was not the case. In a few seconds I felt another shock, and if I remember right, there may have been a third. I felt satisfied on the second or third movement that it was an earthquake. In connection with one of the shocks, I heard a noise as well as felt a movement or shaking of the house.

At Hinsdale, Cattaraugus Co., N. Y., which is not many miles east of Jamestown, there was no earthquake felt on the 23d of Oct., as I learn from a correspondent—an important fact to be borne in mind by the reader.

Rev. William S. Plumer, D.D., of Alleghany, Pa., opposite Pittsburg, writes, "I have no recollection of feeling any earthquake here during the month of October last; nor do I remember to have heard any one speak of it."

Prof. Smith of Jefferson College, Canonsburg, Pa., 20 miles from Pittsburg, writes, "I can only say that no shock of an earthquake was felt in this region at the time alluded to in your letter. Nor was there any thing indicating that there was such a thing in this region. I am in the habit of recording all the atmospheric and other phenomena that fall under my observation, and I would not have failed to notice and record the time and circumstances of an earthquake, if it had been perceptible here. I have enquired of several persons, both in the town and country, but was unable to procure any information on this subject."

A correspondent from Erie, Pa., 90 miles S.W. of Buffalo, writes, "It was felt in various parts of the city, both north and south of us—houses were shaken and the sound was like a heavy wagon passing over frozen ground."

Wm. L. Perkins, Esq., of Painesville, Ohio, on the railroad from Erie to Cleveland, writes, "I have made diligent enquiry, and referred also to the files of the two village newspapers here, but have no recollection, and find no mention of an earthquake here, on the 23d of Oct. last, or about that time..... We have, within about a year past, experienced two, and it seems to

me, three earthquake shocks here. The first, and by far the most energetic, was on the last day of Feb. 1857, I think in the evening. The last was on the 16th of April, 1858, about 6 o'clock, A. M.

F. J. Prentiss, Esq., of Cleveland, Ohio, writes, "I have made repeated and thorough enquiries with reference to the earthquake of which you speak, and am satisfied that it was not known or felt in this part of the State. Within a few weeks past, two shocks were felt in this city, at Painesville and Ashtabula, but I can find no one who knows anything about an earthquake in Oct. last."

Hon. David Campbell of Sandusky, Ohio, writes, "I have made enquiries in relation to the earthquake, but have not heard that it was observed anywhere west of Westfield, N. Y.

From the facts submitted the following inferences may be drawn:

1. That the maximum intensity of this earthquake was felt in Buffalo and its vicinity.

2. That its undulations were propagated in a linear direction, passing through Port Hope, Lockport, Buffalo, Jamestown and Warren, which lie on an arc of a great circle, varying but little from a north and south line.

3. That its intensity diminished on either side of this line, nearly subsiding at Hamilton on the west, and entirely so at Rochester and Hinsdale on the east.

4. That the limits of this line were Port Hope, C. W., which is situated on Lake Ontario, and some point south of Warren, Pa.

ART. XIX.—*The Rocks of Kansas;* by Prof. G. C. SWALLOW of Missouri.

(Read before the American Association for the Advancement of Science, at Baltimore, 1858.)

AT the last meeting of the American Association at Montreal, I presented a geological map of Eastern and Central Kansas. The Eastern portion was colored according to the facts derived from my own personal observations; but the geology of Central Kansas was laid down according to data derived from other geologists, the greater part from Maj. Hawn. At that time I had seen no fossils from the rocks laid down as Lower Carboniferous according to the opinions of other geologists; but the fossils since collected by Maj. Hawn clearly prove a portion of those rocks to belong to the Permian age. There are however some beds between the well characterized Permian strata and the Cretaceous from which only a few imperfect fossils have been ob-

tained. And those few imperfect forms seem to have various affinities; some to the *Triassic*, some to the *Liassic* and others still to the *Jurassic*.

My means of comparing the fossils of the three systems last named, are limited, and I would solicit the criticism of those who have had better opportunities for deciding the age of these doubtful rocks between the Cretaceous and Permian.

I am indebted to Maj. Hawn for nearly all the information presented in the accompanying map and section of the rocks of Kansas.

SECTION OF THE ROCKS OF KANSAS BY MAJ. F. HAWN.

SYSTEM I.—QUATERNARY.

No. 1—150 feet Bluff, the same as in Missouri—2d Ann. Rep. Missouri Survey.
" 2— 4 feet white clay—2d Ann. Rep. of Missouri Survey.
" 3— 15 feet local drift.

169 feet of Quaternary.

SYSTEM II.—CRETACEOUS.

No. 4—45 feet light gray crystalline limestone.
" 5—27 feet slope strewn with light gray calcareous concretions.

72 feet of Cretaceous.

SYSTEM III.—TRIASSIC. (?)*

No. 6—12 feet light gray arenaceous limestone.
" 7—10 feet blue pyritiferous clay.
" 8—15 feet dark brown ferruginous sandstone.
" 9— 8 feet, like No. 7.
" 10—18 feet flesh-colored quartzitic sandstone.
" 11—14 feet variegated, red and white, clay.
" 12—8½ feet white granular gypsum. (Local.)
" 13—12 feet, like Nos. 7 and 9.
" 14—20 feet dark brown ferruginous sandstone.
" 15—13 feet variegated, white and red, clay.
" 16—50 feet soft, coarse, buff sandstone.
" 17—30 feet pyritiferous clay.
" 18—10 feet yellowish brown argillaceous sandstone.
" 19—10 feet thin silico-calcareous strata, containing fragments of trees.
" 20— 3 feet brown impure lignite.
" 21—10 feet black pyritiferous clay, containing numerous stellated crystals of selenite.
" 22—60 feet gray, blue and brown clay, with thin seams of fibrous selenite, and flesh-colored nodules of gypsum.
" 23—75 feet soft, crumbling brick-red sandstone.
" 24—17 feet white clay, with soft concretions of oxyd of iron.
" 25—15 feet conglomerate of coarse sand and small brown pebbles.

420½ feet of Triassic. (?)

* All we mean by this is that these beds are between the *Cretaceous* and the *Permian*. Some of the fossils from these beds seem to be *Triassic*, others *Liassic*, and one probably *Jurassic*.

SYSTEM IV.—PERMIAN.

UPPER PERMIAN.

No. 26—100 feet brown and yellow, cellular and brecciated limestone, alternating with brown, blue and white pyritiferous clay, containing a bed of white granular gypsum, 5 feet thick.
" 27—18 feet conglomerate, of angular, water-worn fragments of limestone, cemented with white argillaceous matter. This bed is local, and may not have its true position.
" 28—15 feet, resembling No. 26, but more compact.
" 29—60 feet dark brown, silicious limestone, alternating with coarse, impure, brown clays, containing crystals of chalcedony and agatized quartz.
" 30—25 feet dark buff, compact limestone.
" 31—45 feet red clay.

LOWER PERMIAN.

No. 32—25 feet brown shale, containing geodes whose drusy cavities are filled with crystals of quartz, and reniform nodules of variegated white and red quartz, often agatized.
" 33—30 feet gray limestone and flint, with beds of brown clay.
" 34—25 feet massive, cherty, magnesian limestone and brown clay; the lower magnesian beds contain angular fragments of jasper.
" 35—20 feet of brown clay, fossiliferous.
" 36—18 feet red clay.
" 37—60 feet silicious, yellow, magnesian limestone, with heavy beds of brown clay.
" 38—10 feet massive bed of flint and limestone.
" 39—25 feet gray and yellow limestone, containing small globular and pear-shaped nodules of chert, and geodes with crystals, alternating with beds of brown and blue clay.
" 40—75 feet brown magnesian limestone, alternating with beds of brown, olive-green and red clays.
" 41—25 feet light buff amygdaloidal magnesian limestone and chert.
" 42— 8 feet heavy-bedded yellow, magnesian limestone.
" 43— 3 feet blue fossiliferous slate.
" 44—15 feet brown slate.
" 45—10 feet brilliant yellow, magnesian limestone.
" 46—17 feet dark brown limestone, with numerous joints of large *crinoidal* columns.
" 47— 4 feet light yellow silicious limestone.
" 48—30 feet red clay.
" 49— 8 feet silico-calcareous slate.
" 50— 5 feet olive-green clay.
" 51— 4 feet red clay.
" 52—10 feet dark gray limestone.
" 53— 6 feet olive-green slate.
" 54— 8 feet dark-blue slate.
" 55— 6 feet bluff limestone.
" 56—16 feet brown slate.
" 57— 3 feet dark blue slate.
" 58—13 feet gray clay.
" 59— 3 feet compact, light buff limestone.
" 60— 5 feet brown clay.
" 61—15 feet blue shale, fossiliferous.
" 62— 3 feet compact, drab, silicious limestone, with small nodules of chert.
" 63— 4 feet brown limestone.
" 64— 3 feet soft, light brown clay.
" 65—15 feet soft, olive-green clay, with a band of red clay, one foot thick.
" 66— 4 feet gray oolitic limestone.
" 67— 4 feet bright olive-green clay.

No. 68— 6 feet dark, buff, oolitic limestone.
" 69— 5 feet dark blue slate.
" 70— 7 feet drab limestone.

Total, 820 feet of Permian Rocks.

SYSTEM V.—CARBONIFEROUS.

1073 feet coal measures, a continuation of, and probably above, the Upper Coal Series of Missouri. (See 2d Missouri Rep., Part I., p. 78.)
170 feet of Lower Carboniferous.

Catalogue of Fossils mainly from the Permian Rocks of Kansas.

NAMES OF SPECIES.	*Coal Measures.*	*Lower Permian.*	*Upper Permian.*	*Triassic (?).*	LOCALITIES.
[A trilobate leaf of an unknown exogenous plant,	..	..	..	*	No. 14 (?) of the foregoing section.
Stenopora crassa, *Lonsdale.*	..	*	..	..	Valley of Cotton-wood.
" spinigera, *Lonsdale.*	..	*	..	..	Rock Creek, Santa Fé road.
Chætetes, three species (*undetermined*).	..	*?	..	..	Valley of Kansas, west of Fort Riley.
Fenestella flabellata (?) *Phillips.*	..	*	..	..	Near Council Grove.
Synocladia virgulacea (?) *King.*	..	*	..	..	Valley of Cotton-wood.
Thamniscus dubius, *Schlotheim.*	..	*	..	..	" " " "
Acanthocladia anceps (?) *Schlotheim.*	..	*	..	..	Near Hay's Ranch.
Phyllopora Ehrenbergi, *Geinitz.*	..	*	..	..	Valley of Cotton-wood.
Archæocidaris Verneuiliana, *King.*	..	*	..	..	Near Lost Spring, S. Fé road.
Cyathocrinus ramosus (?) *King.*	..	*	..	..	Near Council Grove.
Serpula (Spirorbis) valvata, *Goldfuss.*	..	*	*	..	Near Smoky-Hill Fork.
Spirorbis orbiculostoma, *Swallow.*	..	*	..	..	Valley of Cotton-wood.
Phillipsia, *species not determined.*	..	*	..	..	Near Council Grove.
Productus Calhounianus, *Swallow.*	..	*	..	..	Valley of Cotton-wood.
" semireticulatus, *Martin.*	*	*	..	..	" " " "
" Rogersii, *Norwood & Pratten.*	*	*	..	..	South Fork Cotton-wood.
" æquicostatus, *Shumard.*	*	*	..	..	Valley of Kansas, W. Ft. Riley
" Norwoodii, *Swallow.*	..	*	..	..	Valley of Cotton-wood.
Spirifer cameratus, *Morton.*	*	*	..	..	Rock Creek, Santa Fé road.
" planoconvexa, *Shumard.*	*	*	..	..	Valley of Cotton-wood.
" pectinifera (?) *Sowerby.*	*	*	..	..	Valley of Big Blue.
Chonetes Flemingii, *Norwood & Pratten.*	*	*	..	..	Near Council Grove.
Orthisina umbraculum, *Buch.*	*	*	..	..	Generally diffused.
" Shumardiana, *Swallow.*	..	*	..	..	Red Water and Cotton-wood.
" Missouriensis, *Swallow.*	*	*	..	..	Red Water.
Rhynchonella Osagensis, *Swallow.*	*	*	..	..	Valley of Big Blue River.
Terebratula (?) subtilita, *Hall.*	*	*	..	..	Generally diffused.
Monotis speluncaria (?) *Schlotheim.*	..	*	..	..	
" " var. Americana, *Swallow.*	..	..	*	..	Near Smoky-Hill Fork.
" radialis, *Phillips.*	..	..	*	..	" " " "
" variabilis, *Swallow.*	..	..	*	..	Valley of Cotton-wood.
" Halli, *Swallow.*	..	*	*	..	" " " "
Avicula gryphæata (?) *Munster.*	..	..	*	..	Near Smoky-Hill Fork.
Pecten Cleavelandicus, *Swallow.*	..	*	..	..	Valley of Cotton-wood.
" ringens, *Swallow.*	..	*	..	..	" " " "
" acutialatus, *Swallow.*	..	*	..	..	Valley of Kansas.
Mytilus (Myalina) Permianus, *Swallow.*	..	..	*	..	" " "
" " concavus, *Swallow.*	..	..	*	..	White Water.

NAMES OF SPECIES.	*Coal Measures.*	*Lower Permian.*	*Upper Permian.*	*Triassic (?).*	LOCALITIES.
Mytilus (Myalina) squamosus, *Sowerby.*	..	*	..	..	Valley of Cotton-wood.
" " rectus, *Shumard.*	*	*	..	..	Valley of Verdigris.
Myalina subquadrata, *Shumard.*	*	*	..	..	" " "
" Kansasensis, *Shumard.*	*	*	..	..	Near Council Grove.
Bakevellia antiqua, *Munster.*	..	..	*	..	Valley of Kansas.
" pulchra, *Swallow.*	..	*	..	..	" " "
Edmondia gibbosa, *Swallow.*	..	*	..	..	Valley of Cotton-wood.
" Otoensis, *Swallow.*	..	*	..	..	" " " "
" semiorbiculata, *Swallow.*	..	*	..	..	Council Grove.
Nucula (Leda) Kazanensis, *Vern.*	..	*	..	..	Valley of Cotton-wood.
" speciosa (?) *Munster.*	..	..	..	*	No. 18 of foregoing section.
" (*species not determined*).					
Solemya biarmica (?) *Verneuil.*	..	*	..	..	Valley of Kansas.
" (*species undetermined*).	..	..	*	..	Smoky-Hill Fork.
Solen (?) Permianus, *Swallow.*	..	..	*	..	" " "
Cardiomorpha rhomboidea, *Swallow.*	..	*	..	..	Council Grove.
" Kansasensis, *Swallow.*	..	*	..	..	Valley of Cotton-wood.
Cardinia cordata, *Swallow.*	..	*	..	..	" " " "
" subangulata, *Swallow.*	..	*	..	..	" " " "
Cardina (*species undetermined*).					
" Listeri (?) *Sowerby.*	..	..	..	..	
Pleurophorus (?) Permianus, *Swallow.*	..	*	..	..	Smoky-Hill Fork.
Schizodus obscurus, *Sowerby.*	*	*	..	..	Valley of Cotton-wood.
" triangularis, *Swallow.*	..	*	..	..	" " " "
" Rossicus, *Verneuil.*	..	..	*	..	Smoky-Hill Fork.
Lyriodon (Myophoria) orbiculare, *Goldf.*	..	..	..	*	No. 18 foregoing section.
Allorisma lanceolata, *Swallow.*	..	*	..	..	Near Council Grove.
" curta, *Swallow.*	..	*	..	..	" " "
" Minnahaha, *Swallow.*	*	*	..	..	" " "
Murchisonia subangulata (?) *Vern.*	..	..	*	..	No. 26 foregoing section.
" Kansasensis, *Swallow.*	..	*	..	..	Valley of Cotton-wood.
" perversa, *Swallow.*	..	*	..	..	" " " "
Loxonema fasciata, *King.*	..	*	..	..	Valley of Kansas.
Macrocheilus spiratus, *McCoy.*	..	*	..	..	" " "
Naticopsis Pricei, *Shumard.*	*	*	..	..	" " "
Nautilus Permianus, *Swallow.*	..	..	*	..	Smoky-Hill Fork.
" occidentalis, *Swallow.*	..	..	..	..	Valley of Cotton-wood.
Orthoceras Kickapooense, *Swallow.*	..	..	*	..	Smoky-Hill Fork.
Cyrtoceras dorsatum, *Swallow.*	..	..	*	..	" " "

As it appears from this section there is scarcely any perceptible change in the lithological character of the strata in passing from the Coal Measures to the Permian* beds; but the appearance at this point of numerous new fossils, many of which are well known Permian types of the genera *Monotis*, *Bakevellia*, *Schizodus*, *Pleurophorus*, *Synocladia* and *Thamniscus*, clearly indicate the introduction of the Permian age.

* So far as known, there is no want of conformability between these systems (?); but this seems to be no proof that there is no change of systems. Nonconformability is a proof of change; but conformability is no proof of the absence of a change.

In the strata which are marked Lower Permian, Maj. Hawn collected sixteen species of fossils found in the Coal Measures, and forty-one species not seen below the Permian. Nearly all of the forty-one species are Permian types, and sixteen of them seem to be identical with well known European species. In the Upper Permian there are sixteen Permian species and only *one* Carboniferous, *Terebratula subtilita*. So that in all of these beds there are fifty-seven species of Permian fossils and only sixteen Carboniferous; and yet, although the Permian *species* are so much more numerous, the Carboniferous *specimens* are much more abundant, about as ten to one of the Permian forms.

Of these Permian fossils I have described thirty-four new species and Mr. Meek ten.

In an economical point of view, these Permian beds are very important. The gypsum they contain, will enable the farmer to convert the vast sandy plains of Central Kansas into the most productive regions of the West and fill the wilderness with a teeming happy people. It will also supply the commercial demands of the Mississippi valley, which are now met by importation.

Note.—There has been some misunderstanding in relation to the Permian fossils of Kansas. This has all arisen, as I apprehend, from a misunderstanding of the arrangement between Maj. Hawn and Mr. Meek. It may be proper to state in this place, where all the parties interested are represented, the facts as they exist.

Since the first announcement of the discovery of Permian Rocks in Kansas, in the March number of the Journal of Science, several communications have appeared in rapid succession disclosing the existence of that formation in various parts of the West.

My paper declaring the discovery of several well known Permian fossils in the valley of the Cotton-wood in Kansas, was read in the St. Louis Academy of Sciences on the 22d of Feb. On the 2d of March, Messrs. Meek and Hayden announced the discovery of Permian fossils by Maj. Hawn on the Smokey-Hill Fork in Kansas, and by Dr. Cooper near Helena in the same Territory, in the Albany Institute. On the same day, their announcement was read in the Academy of Natural Sciences at Philadelphia.

On the 8th of March Dr. B. F. Shumard announced the discovery of Permian Rocks by Dr. G. G. Shumard in the Guadaloupe mountains in New Mexico.

Dr. Norwood's letter showing the existence of Permian Rocks in Bureau, La Salle, and Henry counties in Illinois, was read in the St. Louis Academy on the 5th of April.

Since these announcements were made, Prof. Hall has informed me that he has determined the existence of Permian Rocks in Iowa and Illinois.

It is but just to state in this connection, that so far as I know, Mr. Meek first discovered the Permian character of the Kansas fossils, and communicated to Maj. Hawn his impressions* on the 3d of Sept. 1857. He also mentioned his discovery, as I am informed, to some friends at the Smithsonian Institution on the 17th of January, 1858, and communicated the same to Prof. Leidy on the 16th of March.

Maj. Hawn frankly declares, that his first impressions that the rocks in question might be Permian are due to Mr. Meek.

Such are the facts as I understand them. If I am wrong, let the correction now be made. If any one knows anything contrary to these statements he will confer a favor by making it known at this time.

ART. XX.—*Contributions to Analytical Chemistry;* by HENRY WURTZ, of New York City.

1. *On the Action of Nitric Acid in the cold upon some Metallic Solutions, with new modes of obtaining pure Compounds of Barium, Strontium, and Cadmium.*

(Read before the American Association for the Advancement of Science, at Baltimore, 1858.)

IN the course of the investigation which forms the subject of a previous paper, on the action of hot nitric acid on the chlorids, in the last number of this Journal, it will be observed that nitric acid was found to have also a powerful decomposing action upon some chlorids at the ordinary temperature; and this observation has rendered imperative the commencement of a complete examination of its action upon *all* the chlorids in the cold. This examination is in progress, but some of the results already obtained being of important practical value, I take this opportunity of making them known without delay, in the form of a brief preliminary notice.

To each chlorid in concentrated solution was added twice its volume, or more, of strong nitric acid. With the chlorids of barium and cadmium were obtained immediately granular crystalline precipitates, so voluminous that unless too much nitric

* This communication to Major Hawn was in the following language:—"The fossils from Smokey Hill are of a rather suspicious character, that is, they lead me to think these beds may be, after all, *Triassic* or *Permian*, though they may belong to the Upper Coal Measures."

acid is added, the liquid becomes almost solid. With chlorid of strontium the precipitate is more slowly obtained. In each case, the precipitate, after being rinsed two or three times with pure nitric acid and dried upon porous earthenware, was entirely composed of nitrate without any chlorid. A solution of corrosive sublimate gave also by the same treatment a large crystalline precipitate, which appeared, however, to be chlorid and not nitrate of mercury.

The chlorids of potassium and sodium did not give immediate precipitates, but on standing for a few hours in the cold, crops of large crystals were obtained, which were easily recognized as nitrates. The liquid poured off from these crystals gave, on addition of alcohol, further crystalline precipitates of nitrates of potash and soda.

Experiments with the chlorids of calcium, magnesium, cobalt, nickel, zinc, copper, and ammonium, protochlorids of iron and tin, bichlorid of platinum and sesquichlorid of chromium have as yet given no results, but are to be repeated, with modifications. Mitscherlich states* that *nitrate of lime* "is precipitated from its aqueous solution by concentrated nitric acid as a crystalline powder."

The precipitation of solutions of the three metals first mentioned, barium, strontium, and cadmium, by strong nitric acid, which under favorable conditions I find to be almost perfectly complete, the supernatant liquid retaining but traces of the base, occurs to me as capable of being made use of practically in important ways. It may be doubted whether any method was ever heretofore devised by which barium and strontium compounds, particularly the latter, can be obtained perfectly free from lime, or cadmium compounds perfectly free from lead, tin, antimony, etc. This behavior with nitric acid, however, furnishes us at once with the means of accomplishing these desiderata, as the nitrates of the contaminating bases, being present in very small quantities, must remain in solution in the excess of nitric acid. Nitric acid which has been employed for such precipitations is for many uses as good as before, and may be purified by simple distillation, or concentrated by evaporation and used again for the same purpose.

It is unnecessary to do more than allude to the importance of our being able to obtain compounds of these metals perfectly pure—in the determination of their equivalent weights, for instance.

The chlorids of barium and strontium are precipitated by muriatic acid, as well as by nitric; so that when pure chlorids are

* Gm. Handbuch, ii, 212.

required instead of nitrates, the former acid may be employed. Chlorid of cadmium, however, seems to be soluble in chlorohydric acid.

2. *On some Improvements in the Preparation of Hard Minerals for Analysis.*

Read before the American Association for the Advancement of Science, at Baltimore, 1858.

NOTHING, it may be asserted, tries the proverbial patience of the chemist more than the preparation of hard minerals for analysis. The following suggestions are therefore offered in the hope that they may be of some small service in lightening this species of unappreciated toil.

The ordinary method of reducing to fine powder by first crushing to coarse powder in a diamond mortar, and then triturating in an agate mortar, is open to several serious objections. In the first place, the diamond mortar, of the usual construction in three pieces, is difficult to manipulate with, and extremely liable to get out of order. Its preservation from *rust*, which immediately destroys its efficiency by causing friction, is almost impossible in the acid atmosphere of a laboratory; and, moreover, the quantity of material that can be operated upon with it at once is very small. An obvious improvement adopted by many chemists, is to use in its stead a *deep* mortar and pestle of the common form, composed of steel, or far better, of *white cast iron*, which besides being harder is less liable to rust. An instrument of this latter description I have used for several years. Another still more serious drawback, however, to this as well as to the diamond mortar, is the inevitable introduction into the powder of more or less *iron* in small particles chipped off by the sharp angles and edges of the fragments crushed. The agate mortar is also objectionable, on account of the very small quantity that must be operated upon at a time, and the contamination of the product with *silica*, proceeding from abrasion of the agate. Some analysts have proposed to overcome this latter objection by *weighing* the agate mortar before and after the operation, to ascertain the quantity of silica ground off, but this involves many impracticabilities, one of which is the necessity, with our ordinary balances, of using a mortar of the smallest size; and the others it is unnecessary to detail.

It has occurred to me therefore, that if the agate were dispensed with entirely, the levigation being completed in the hard white iron mortar, and that if some means could be devised of subsequently removing the abraded metallic iron from the powder, without otherwise affecting the composition of the latter, a step in improvement would have been accomplished. When the mineral contains no ingredient acted upon by *diluted acids*,

the means of effecting this are so obvious that no doubt every analyst has adopted them upon occasion; but the cases in which this occurs are not often met with. Especially when working upon *iron ores*, magnetic, hematitic or silicious, containing *carbonates*, *phosphates*, etc., is the use of acids inadmissible.

We possess, however, agents which while readily dissolving *metallic* iron, are supposed not to act upon its oxyds. *Chlorine water* is such an agent; and in cases where the mineral contains no carbonates, chlorine water may be used without fear of dissolving any *anhydrous* oxyd of iron present. *Limonite*, if present, would undoubtedly be dissolved in small quantity by the sesquichlorid of iron formed. It is scarcely necessary to remark that chlorine water used for this purpose must be freshly made, and made *in the dark*, and kept in the dark before and during the operation, in order that it may contain no acid. Aqueous solution of *bromine*, or still better, of *iodine*, may be substituted for that of chlorine. It was hoped that with iodine water, even minerals containing carbonates might be treated, and in the course of an extensive series of analyses of magnetite ores, (all containing both carbonate and phosphate of lime,) upon which I have been engaged, many trials were made in reference to this point. It was found that even when the experiment was made without access of air, and in the dark, traces of lime were dissolved. In fact it could not be otherwise, for an excess of the solvent being present, sesquiodid of iron must be formed, which is then decomposed by the carbonate of lime. With chlorine water the quantity of lime dissolved was large.

There is another solvent that may be used to accomplish the same purpose as the above, namely, a *neutral* solution of (sublimed) *sesquichlorid of iron*. This is, however, open to the same objections, because while dissolving the metallic iron, it will also dissolve the carbonates and limonite.

It is plain, therefore, that some additional precaution must be contrived before we can attain completely the object proposed. This is fortunately furnished us by the well known power of solutions of ammoniacal salts to dissolve the earthy carbonates when boiled with them. The method then which I at present propose, is to boil a weighed quantity of the powder first with a solution of sal-ammoniac or nitrate of ammonia, until the lime, magnesia, etc., present in the form of carbonates, are dissolved. These are then determined separately, and the remaining powder is treated with iodine water to remove the metallic iron.

Of course the *carbon* contained in the metallic particles will remain, but the quantity of this will be so small that it may usually be neglected.

Other substances, of an oxydable character, may be present in some cases to interfere with complete success, such as metallic

sulphids, and particularly *pyrrhotine*. A portion of pyrrhotine, from the apatite locality near Hurdtown, New Jersey, was digested in fine powder, in the dark, with a brown aqueous solution of iodine (freshly prepared from iodine which had been ground to fine powder and washed repeatedly to remove all free acid) for forty-eight hours. The liquid had then become colorless, and gave a large green precipitate with ammonia, and a black one with sulphid of ammonium. Pulverized *pyrites* treated in the same way did not remove the brown color of the liquid, and the latter had dissolved but a trace of iron.

I must not omit to remark that the iodine solution should not be allowed to stand upon the powder for an unnecessary length of time, especially if air has excess, for in that case a portion of the iron dissolved will sooner or later be deposited again as a basic salt.

Some further suggestions as to details may be acceptable. The mode which I adopt is to reduce the whole mass of substance to be analyzed first to a coarse powder in the white iron mortar, with the aid of a fine sieve in the ordinary way, and then to *elutriate* it (also in the iron mortar) in small quantities at a time, using, however, in this operation, *alcohol* instead of water. I may remark here that water should never be allowed to touch the iron mortar. It should always be washed with *alcohol*, and dried perfectly on the sand-bath after use, thus preserving it from rust. If it should have become rusted internally by exposure to acid vapors, some sand wetted with alcohol should be ground up in it. An acid should never be used to remove the rust, because cast iron (as well as steel) is always more or less *porous*, and a portion of the acid would inevitably be absorbed as a protosalt of iron into the pores, to reappear afterwards as sesquioxyd, or basic sesquisalt, upon the surface.

ART. XXI.—*Chemical Examinations connected with a Bullet which had been Imbedded for more than Forty Years in the Lung of a Man;* by HENRY WURTZ, of New York city.

Read before the American Association for the Advancement of Science, at Baltimore, 1858.

While delivering the course on Chemistry in the medical department of Queens College, Kingston, Canada West, during the past winter, the case in question came under my observation, and seemed to me a rare opportunity for a chemical examination of the action undergone by metallic lead when imbedded in a human viscus, and although the examination made, from want of time and other causes, was very imperfect, the results obtained are probably worthy of being recorded. The following history of

the case was drawn up at my request by the gentleman who made the dissection, and found the ball, Dr. Alexander Bethune, now a graduate of the Institution:

William Kelly, aet. 76, a pensioner, a native of Ireland, was admitted into the Kingston General Hospital, September 25, 1855. He had *hemiplegia*, and as it was considered incurable he was sent to the House of industry, where he remained only a few days, and then returned to the hospital, in which he continued until the day of his death, December 17, 1857.

Post-mortem appearances: On removing the calvarium more than a pint of bloody serum gushed out. The dura mater was found much thickened and closely adherent. The gray matter of the right hemisphere was softened and contained a clot the size of a pea. The lining membranes of the ventricles were thicker than natural, and they contained serum and organized lymph, with traces of recent inflammation. When the thorax was opened a prominence was observed in the middle lobe of the right lung, and on cutting into it about the depth of an inch, a bullet was found, enclosed in a cyst, and firmly adhering to its wall at several points. On examining the walls of the thorax, a cicatrix was found between the fourth and fifth ribs, corresponding to the prominence produced by the bullet.

In the early part of his life, the deceased had been a soldier in the British army, and was engaged in the Peninsula war. In one of the engagements there he received a wound from a musket ball, which entitled him to a pension. As he was engaged in no war but that of the Peninsula, and had no marks of any other wound upon his body, the bullet found in his lung, more than forty years after, must have been that which produced the wound for which he received a pension.

ALEXANDER BETHUNE.

Queens College, Kingston Feb. 1, 1858.

I may add that the wound is believed to have been received at least as early as the last seige of Badajoz, which occured in the year 1812, and consequently forty-five years ago; and that the hemiplegia was of the right side, or on the same side as the ball.

The ball, as delivered to me, appears to have been a common ounce musket ball, but is irregular in shape, having evidently undergone corrosion. It now weighs 370 grains, indicating a loss, if originally an ounce in weight, of more than one hundred grains. Two spots appeared on opposite sides, where adhesion to the walls of the cyst had existed. These spots are coated with a hard whitish substance, which cuts like horn, and blackens when heated, with a smell of burning animal matter, leaving afterwards an infusible white ash. Near one of these spots was

a small incrustation of a chalky white color, about one-eighth of an inch in diameter, which when detached was found to penetrate somewhat beneath the surface of the lead, and when submitted to careful qualitative analysis, was ascertained to consist wholly of *chlorid of lead*, containing no trace of either phosphoric or sulphuric acid. The ball was then boiled in distilled water and gave a liquid hard to filter clear, which contained considerable chlorid of lead. In places the ball had a very thin brown coating, too small in quantity to be satisfactorily determined, but which was probably also chlorid of lead, colored with organic matter.

A piece cut from the wall of the cyst was treated with chlorohydric acid and chlorate of potash, and the solution examined for lead without success, but the material was so small in quantity that the result is not satisfactory. A piece of the lung itself, taken from the neighborhood of the cyst, was then treated in the same way. The solution obtained gave with sulphohydric acid a small brown precipitate, which was collected on a small *purified* Swedish paper filter, and the latter washed, dried and burned to ashes. The ash, fused with carbonate of soda on charcoal, and manipulated in the ordinary way in the agate mortar, gave a multitude of spangles of a soft white malleable metal, which being collected on a watch-glass, dried, dissolved in a drop of nitric acid and the solution evaporated to dryness, gave with a drop of a solution of sulphohydric acid a deep brown coloration.

I was very desirous to obtain a portion of the *liver*, (which was not yet exposed when I viewed the body,) and left directions that it should be saved, which were unfortunately not complied with, the liver having been thrown among a number of like viscera from other subjects in the dissecting room, so that it could not again be identified. A piece of *muscular tissue*, however, taken from the muscle of the diaphragm, was examined and lead found, apparently in greater quantity than in the lung.

It is evident from these results, that the lead of the bullet has undergone solution in the cyst as chlorid, and passed as such into the circulation, to be deposited again in insoluble forms in other parts of the system, as is usual with the so-called *cumulative poisons*.

The question whether the paralysis and post-mortem appearances had any connection with the presence of the lead, I shall leave for the consideration of medical men and toxicologists.

ART. XXII.—*Suggestions Regarding Economical Applications of Glycerine;* by HENRY WURTZ, New York city.

Read before the American Association for the Advancement of Science at Baltimore, 1858.

IT must be apparent to every one who considers the peculiar qualities of the substance, glycerine, namely: its resemblance to oils in not being volatile at ordinary temperatures, while, unlike them, it is miscible with water, alcohol, etc.; its resistance to congelation, not being perfectly solid even at the freezing point of mercury;* its unchangeability; its agreeable taste when pure, and harmless action upon the system; its wide range of solvent powers; together with the quantity in which it may be cheaply procured; that it must in future fulfill important purposes, not only in pharmacy, but also in the arts. Accordingly, we find that technical applications have already been proposed for it. Barreswil's method† of preserving clay, which is to be used for moulding purposes, in a moist and plastic state, may be alluded to as an example.

Some uses, which are probably new, have occurred also to me.

In the first place, its conjunction of the property of compatibility with human digestion and assimilation, with that of non-evaporation and even *absorption of water* from the air, suggest applications in the preservation of articles of food and luxury which are injured by desiccation. As an example of minor importance, if *mustard*, for table use, were mixed with diluted glycerine, instead of water or vinegar, the usual vehicles, it would retain its liquidity indefinitely without drying up. So of many other condiments.

A more important application, however, of a similar kind, would be in the preparation of articles of *confectionery* composed of sugar, preserved fruits, chocolate, etc., which are frequently met with enveloped in *tin foil* to prevent their desiccation. The same object might be accomplished more effectually, and probably more economically, by admixture in the process of manufacture with a certain proportion of pure glycerine.

Another article of luxury, of still more extensive consumption, the consumers of which demand that it should be preserved for them in a *moist* state, is that known as "chewing tobacco;" and a vast consumption of tin foil arises from this requirement of the tobacco chewers. I have repeatedly prepared small quantities of chewing tobacco (the variety called "fine cut") for persons addicted to its use, by admixture with a little glycerine, and always very much to their satisfaction. In the preparation of

* Berthelot, in Lieb. and Kopp's Jahresb, 1854, p. 448.

† Nickles' Correspondence in American Journal of Science, (2) xvi, 100.

this drug, the manufacturer must also please the palate of the consumer by introducing some *dulcifying* ingredient. Common sugar or molasses, however, will not answer the purpose, because they render the mass liable to ferment and turn sour. An infusion of the root or extract of *liquorice* is therefore usually resorted to. This does not, however, keep the tobacco *moist*, as molasses would do, and to attain this it is necessary to press into solid compact masses and pack into tight cases, or in the case of the finer qualities, to enclose in wrappers of tin foil. In view of these facts, glycerine will be seen to supply every requirement of the tobacconist, as it will not only keep his product *moist* for an indefinite time, even when exposed to the air, but will also *sweeten* it. He may almost look upon glycerine as made specially for his use.

The common *water meters*, used for measuring the consumption of illuminating gas in houses, are open to two strong objections, namely: when in a warm situation the water rapidly *evaporates*, and when in a cold place it *freezes*. To avoid congelation, the usual expedient is to fill the meter in cold weather with *alcohol* or whiskey, thus rendering the first mentioned difficulty, that of evaporation, still more inevitable.

Now what liquid do we possess which is practically free from both these objections of evaporation and congelation? Evidently *diluted glycerine*. I propose, therefore, as a substitute for both water and alcohol for filling gas meters, *glycerine* (sufficiently diluted to prevent its absorption of more water from the gas, and increasing in volume to any important extent), thus rendering the meter independent of attention within the ordinary limits of temperature.

For lubricating the bearings of fine machinery also, and particularly of *chronometers*, glycerine seems to me worthy of a trial, as it is unchangeable by the atmosphere, and remains fluid at temperatures which few or none of the oils will resist. For chronometers, pure *oleine* and *oleic acid* have been used, but the former thickens on exposure to the air,* and the latter congeals at a few degrees below the freezing point of water.†

Other uses occur to me, such as in the preparation of *copying ink*, in *water color painting*, and in the preservation of dried plants for *herbaria* in a flexible state; mere allusions to which may at present be sufficient.

* Loewig's Chem, der organ. Verbind. ii, 511.
† Ibid. ii, 200.

ART. XXIII.—*Examination of the Soluble Basic Sesquisalts;* by JOHN M. ORDWAY.

IT was mentioned in a former communication,* as a proposition likely to prove universally true, that the soluble normal salts of the higher oxyds—that is of those bases containing more than one equivalent of oxygen to one of metal—may be made more or less basic and still remain soluble. In finding out how far this principle arrived at by a partial induction, may apply to particular cases, but little help is to be derived from the recorded labors of others. With regard to this hitherto unheeded matter, the fullest treatises on chemistry give only a few isolated facts; while such works are by no means free from hasty and partial statements, which may not, indeed, be of themselves positively incorrect, but yet are calculated to impart erroneous ideas. Thus Berzelius says under the head of *chlorure aluminique,* "Si l'on ajoute de l'ammoniaque à la dissolution aqueuse de ce sel, mais sans en mettre assez pour que toute l'alumine soit précipitée, il se forme un soussel insoluble." Were this taken to be the whole truth, it would be deemed unnecessary to make further inquiries in that direction, as one would naturally infer that a soluble subsalt was out of the question; when, in fact, over two-thirds of the acid may be neutralized without permanent precipitation, and the "*soussel insoluble*" is almost the last thing that forms.

The investigation, then, is quite extensive, and must be carried on mostly by special experiments requiring much care, patience, and time. I have thus far been occupied chiefly in examining the salts of the common sesquioxyds, with the primary view of giving more fulness to the history of the sesquinitrates. But the work so expands that its completion must be set forward to a distant day, and in the meantime it may be well to make known some of the facts ascertained, which, from their theoretical and practical bearings, seem entitled to the attention of chemists.

Before taking up the oxyds in detail, it may be remarked, that the soluble compounds, with rare exceptions, appear to be wholly incapable of crystallization. A *gum-like* character is their peculiar distinguishing feature. By spontaneous evaporation they become tough, shining, transparent masses—the less basic of them being again soluble in pure water. Hence when we wish to obtain crystals of the normal salts, an excess of base must be carefully avoided. It must have been from want of attention to this circumstance that some sesquisalts have been described as

* Amer. Jour. Sci., (2) xxiii, 223.

amorphous, which, in reality, admit of very distinct crystallization.

Salts may be made basic in various ways.

The purest and most reliable products are obtained by the method of direct combination; that is by digesting the hydrated oxyds with the normal salts, or with less than the equivalent quantity of acid. And usually the oxyd precipitated from a nitrate is preferable, since the nitrates are the most completely decomposed by alkalies, and therefore afford the purest hydrates. Nor is it altogether a matter of indifference what precipitant is used; for under certain influences most of the sesquioxyds are liable, even in the hydrated condition, to assume an inert allotropic state. For iron, chrome, and cerium, ammonia does well. But to throw down alumina, it is best to use carbonate of ammonia or an alkaline sulphuret.

In the second place, it is sometimes possible by direct oxydation to make a soluble salt with less than the normal quantity of acid. Thus, in cold weather, 2Fe, and 3N . O_5 may be made to yield N O_2 and Fe $\dot{N}_2$. When crystals of protosulphate of iron are put into half their weight of nitric acid of sp. gr. 1, 2, a rapid oxydation ensues, with the evolution of nitric oxyd, and the resulting dark red liquid must contain three equivalents of peroxyd of iron, held in solution by six equivalents of sulphuric acid and one of nitric. Another instance is afforded in the change of protochlorid of tin into a soluble bibasic perchlorid, by means of chlorate of potash.

A third plan, applicable only in some rare cases, is to expel a portion of the acid from a normal salt by a moderate and protracted heating. Nitrate of alumina crystals exposed for several hours to a steam heat, were found to have lost nearly half their acid, the perfectly soluble residue having about the composition $\dot{Al}_2\dot{N}_3 + H_{23}$. A solution of chlorid of aluminium by evaporation to dryness, parted with one-third of its acid without losing its solubility.

Fourthly, we may often operate advantageously by precipitation. A portion of the acid can be removed by another base, in the form of an insoluble salt, and the rest of it may be replaced by another acid in the way of double decomposition. Treated with the proper quantity of carbonate of lead, chlorid of chrome becomes tribasic, and this product gives with acetate of lead, a tribasic acetate of chrome. A tribasic chlorid of aluminium may be neatly and expeditiously prepared by putting with an equivalent of the sulphate, one equivalent of chlorid of barium and two of precipitated carbonate of baryta.

The fifth and easiest way is to neutralize part of the acid of a normal salt by a more powerful base—the whole being left in solution. By this mode the difference between protoxyds and

sesquioxyds is very strikingly illustrated. Thus if we add ammonia to nitrate of zinc, there is a permanent precipitation from the outset. But if weak ammonia be gradually dropped into pernitrate of iron, there is no lasting precipitation, till about seven-eighths of the acid is combined with ammonia. There is a slight opacity induced, even at an early stage of the process, but the liquid becomes quite clear again by standing some hours after each addition of ammonia. The nitrates of chrome and alumina bear less ammonia, but the opacity disappears in a much shorter time. The chlorids behave very much like the nitrates. In analyzing crystals of hydrated chlorid of iron—$Fe_2\,Cl_3\,\dot{H}_6$—by means of carbonate of baryta, at least three-fourths of the acid was united with the baryta before any ferric oxyd was deposited. The sulphates of iron, chrome, and alumina allow half their acid to be neutralized with ammonia, and the liquid in each case clears itself perfectly in a few moments.

With regard to common alum, this property has long been known, as well as the fact that the pure sesquibasic sulphates of iron, alumina, and chrome, and the bibasic sulphates of zirconia and glucina, are soluble and uncrystallizable. It will be seen from what follows, that it generally requires far more of sulphuric acid than of most others, to keep the sesquioxyds in solution.

Iron.—Peroxyd of iron very rarely performs the office of an acid; it is one of the weakest of the bases, and among all the oxyds of its class it is that which needs the least quantity of acid to dissolve it. This last statement is indeed somewhat parodoxical, for it is well known that a protosalt of iron when oxydized by exposure to the air, lets fall a part of the resulting peroxyd—a fact that has always been dismissed with the very superficial explanation that, as a persalt contains more acid than a protosalt, there is nothing for a part of the newly formed base to combine with.

But it should be noticed that ferric oxyd exhibits quite distinctly the power of existing in two states,—being, in the one, very susceptible of combination, and, in the other, almost devoid of affinity for acids. It is usually in the first condition when it has been precipitated cold by an alkali, from any of its salts. While most of the normal ferric salts, when mixed with a large quantity of water and boiled, deposit an ochrey sediment which is very slow to dissolve in dilute acids,—it being in the same allotropic state as that dropped by a protosalt oxydizing in the air. The various salts differ much in the extent to which they yield to such decomposing and modifying influences. Twenty grams of the crystallized nitrate of iron boiled with about 800 grams of water, gave a light brown precipitate and a liquid almost colorless when cold. The liquid contained all the acid and one-fifth of the iron. The rusty precipitate subsided without

difficulty in the mother liquor, but would not settle at all in the wash water, and as it passed through the pores of the paper, it could not be collected on a filter.

A similar substance forms—even more difficult to settle and collect, and as slowly acted on by acids—when an excess of iron is used to prepare the commercial nitrate.*

A solution containing one per cent of dry perchlorid of iron, became rusty by boiling, but would not settle at all. Yet a small quantity of chlorid of sodium thrown in, effected an immediate separation of the rust, and it was now completely kept back by a filter. The cold supernatant liquor was of a pale yellow color, and retained two-fifths of the iron and six-sevenths of the acid.

Fluorid of iron boiled in 300 parts of water deposited half of its base.

One part of the sulphate,—$\dot{F}e\,\bar{S}_3\,\dot{H}_9$,—dissolved in 84 parts of water, afforded by thorough boiling, a quickly subsiding precipitate. There remained in the clear, almost colorless liquor, about 57 per cent of the oxyd and 93·5 per cent of the acid. This liquid by boiling with sulphate of soda, suffered a fresh deposition of rust, which, however, disappeared by standing a day or two.

Pure acetate of iron, largely diluted, underwent no change during a thorough and long continued ebullition. Some acetate made by double decomposition from the sulphate, was not at all affected while fresh, but after it had been made some time, heat threw down all the iron, to the last trace, leaving the liquor colorless. Sulphate of soda, without the application of heat, caused most of the oxyd to fall in a few hours.

A solution of the protacetate changes very rapidly by exposure to air, and gives a great quantity of rust.

Why the inert oxyd should form in any case, or why the previous addition of an acid should sometimes prevent its formation, is something that yet remains to be ascertained.

But whatever be the cause, a clear understanding of the fact that the hydrated sesquioxyds may exist in different allotropic states, is of some importance, especially to those concerned in the tinctorial art. It is evident that good success in dyeing can be expected only when the mordants are kept in the active condition throughout all the preliminary operations. In calico print-

* There is no after remedy for trouble of this kind, but to add an excess of nitric acid to the spoiled stuff, and leave it for several weeks or months, till the rust is taken up, and then proceed cautiously with more iron.

But all difficulty may be avoided—as it will be well for dyers to recollect—by using *weighed* quantities of the materials to start with. Thirteen lbs. of iron turnings and 109 lbs. of aquafortis at 32° B. or 57° T., have been found, by frequent trials, to give an excellent product.

ing, a protacetate of iron made with crude pyroligenous acid, is found to answer a better purpose than a purer acetate. Some chemists account for this by saying that the pyrogenous matters prevent the oxydation of the iron from going too far in the drying and aging of the cloth. But granting it to be the magnetic oxyd which goes to make a black dye, it must be admitted that the vegetable principles of the tannin family themselves readily reduce an active peroxyd of iron to the right degree of oxydation; for careful experimenters have proved that the full persalts can be made to give good blacks and purples. The good effects of pyroligneous acid must be owing mainly to its power of preserving the oxyd of iron in the active state. The normal ferric salts are too acid and corrosive to be safely used on cotton; but something might be gained by employing the tribasic pernitrate which is not liable to passivity, and would probably do away or at least shorten the "*aging*" process—there being no acetic acid to get rid of by long exposure.

The polybasic nitrates of iron formed by direct combination, have been already examined, and it was shown that at least eight equivalents of the oxyd might be held in solution by one equivalent of acid. We cannot go quite so far by the method of neutralization, since the basic compounds are less soluble in saline liquids than in pure water. By direct oxydation it is difficult to get beyond a bibasic nitrate. Volatilization of the acid from the crystals by a moderate heat is attended with the formation of a rust.

Perchlorid of iron may be made quite as basic as the nitrate. Berzelius mentions a basic combination, not transparent, obtained by adding the hydrate to a solution of the chlorid, till the former ceases to dissolve. And after saying that *Phillips* give its composition as $Fe_2 Cl_3 + Fe_4$, he expresses a doubt as to the correctness of the analysis, because the solution tried could not have been free from a chlorid of the precipitant. Now time is a very important element in the production of the highly basic compounds. One may easily be deceived as to when the hydrate ceases to be dissolved, and may set down as opaque, that which by longer digestion becomes quite transparent. By successive steps, we get pretty easily as far as $Fe_2 Cl_3 + Fe_{11}$, and in the course of several weeks I have gone as high as $Fe_2 Cl_2 + Fe_{23}$. This product must be free from a "chlorid of the precipitant," since the hydrate was made from the crystallized nitrate, and very thoroughly washed. The liquid thus made is perfectly transparent, though so deep colored that only an exceedingly thin stratum can be seen through. It bears dilution or boiling to any extent; but most saline solutions throw down all the iron. When dried up by spontaneous evaporation, it no longer dissolves

in pure water, while the decabasic and the still more acid compounds do not lose their solubility by drying.

Bromohydric acid takes up at least five equivalents of ferric oxyd.

The iodids form with more reluctance, and have a strong smell of iodine, which becomes weaker, however, as the amount of base increases. By long digestion Fe_5 I.H. was at length formed.

The fluorids make an apparent exception to the general rule, for nothing less than three equivalents of fluorhydric acid would dissolve an equivalent of ferric oxyd; nor could I succeed in making soluble basic fluorids of aluminium or chromium. But this will appear less strange, if we consider that the normal sesquifluorids of these metals are perfectly soluble in water, while most protofluorids will dissolve only in a large excess of fluorhydric acid or in some other acid.

It also requires three equivalents of tartaric acid to take up two of ferric oxyd. And yet acid tartrate of potash dissolves two equivalents of hydrated sesquioxyd of iron, making Fe_2 K...C_8 H_4 O_{10}.

The sulphite, like the sulphate, can only be made sesquibasic without disturbance.

Carbonic acid has little affinity for sesquioxyd of iron; yet an alkaline bicarbonate may retain it in solution for a time; and it is probably a basic carbonate that is present in this case, and not the mere oxyd, as the old name—"Stahl's alkaline tincture of Mars"—would imply.

The basic acetates are not new. Berzelius says: "L'acide acétique forme, avec l'oxyde ferrique, un soussel soluble, qu'on obtient en dissolvant de l'hydrate ferrique récemment précipité jusqu' à saturation complète dans l'acide acétique. On a ainsi une solution rouge foncée, qui renferme, suivant *Bette*, Fe $\bar{A}c$, et suivant *Janssen*, Fe_2 $\bar{A}c$." Both are right, for the tribasic acetate forms in a day or two, and further solution goes on very slowly; but by several weeks digestion, the sexbasic acetate may be brought to a finished state—and here the saturation seems to be indeed complete. It is not unlikely that as medicinal preparations or as counterpoisons, the nitrates would be preferable to the acetates, since they can be made so much more basic and are less likely to become injured by keeping.

A sexbasic formiate can be made with ease.

Chrome.—Chromic oxyd precipitated by carbonate of ammonia with the aid of heat, has a bluish shade, and is insoluble in weak acids. But the dull green oxyd precipitated cold with caustic ammonia, is usually of the active modification. Chromium falls behind iron in the extent to which its salts can be rendered basic.

The nitrate dissolves enough oxyd of chromium to become octobasic; but as beyond this it does not remain perfectly trans-

parent, it is not easy to tell just how far we can go. In the way of neutralization, more than two-thirds of the acid may be withdrawn, without any permanent loss of transparency. Crystals of nitrate of chrome exposed to a steam heat till they lost 39 per cent of their weight, left a dark green, tough mass, readily soluble in water, and having about the composition $\dot{C}r\,\dot{N}_2\,\dot{H}_{12}$. By still further heating, the crystals lose more acid and water, and the spongy brittle residue dissolves rapidly in water to a very deep brown liquid, containing chromate of chrome as well as nitrate.

The basic chlorids of chrome are more fluid and clear than the nitrates. One equivalent of chlorhydric acid has been found to take up six equivalents of the hydrate. The acid of the normal chlorid may be neutralized with ammonia till there remains $Cr_2\,Cl_3 + \dot{C}r_5$; but after this the opacity is very slow in disappearing. From the researches of *Moberg*, it appears that the chlorid maintained for some time at 150° C., becomes sesquibasic and remains soluble.

By the method of direct combination, the iodid and the bromid were, without difficulty, made tribasic.

While the basic chrome salts prepared with the mineral acids, are of a deep green color, the basic acetates and formiates are purple. The acetate may be made tribasic, but it is difficult to go further. The formiate can be made bibasic.

Alumina.—When alumina is thrown down by caustic ammonia in excess, it is very apt to be insoluble in weak acids. In fact it appears to be in the same state as that deposited by a saturated alkaline solution, or that occurring in raw plastic clay.* But if carbonate of ammonia is used, we get a gelatinous precipitate, which, even after drying, readily dissolves in acids, with the aid of heat, carbonic acid being given off. Sulphid of sodium likewise precipitates the earth in the active condition.

Sulphate of alumina cannot, by any mode, be made more than bibasic without becoming turbid.

By direct union, the nitrates, the chlorid, the bromid, and the acetate have been made sexbasic; but here we come to a definite limit. A heat maintained for some time near the boiling point, is needed to finish these combinations. The resulting liquids are very slightly opalescent. They bear dilution and boiling. They are incompatible with sulphates, but allow the addition of nitrates or chlorids.

* In the manufacture of alum by the French method, the alumina is rendered more active by the calcination of the clay. Why exposure to a dull red heat should have such an effect, it is not easy to tell. But as the active state of the earth seems to be induced by the influence of acids, it may be that heating alumina moderately in intimate contact with silicic acid, brings about a change; somewhat as finely divided silica is itself altered by mixing it with lime and burning, for the manufacture of artificial hydraulic cement. Too great a heat, in either case, causes too close a union of acid and base.

In the way of neutralization the chlorid and the nitrate may become nearly sexbasic without any lasting diminution of transparency. A solution of the normal chlorid slowly evaporated to dryness, was found to have left a bibasic residue that dissolved completely in water. Crystals of the nitrate by exposure to a steam heat for thirty-six hours lost half their weight, and the perfectly soluble product consisted of $\dot{A}l_2\,\dot{N}_3\,\dot{H}_3$.

A tribasic formiate of alumina can be prepared, but it does not keep well.

The acetate suffers only half of its acid to be neutralized with ammonia. More alkali causes it to thicken like starch. This salt parts with most of its acid in drying. If the normal acetate contains any sulphate,—even that of alumina,—boiling renders it opaque.

It is not acetate of alumina, but a solution of the tribasic sulphate in acetic acid, that is used as a mordant for reds in calico printing. And for the brighter tints, this solution is still prepared, as it was in the infancy of science, by partially decomposing alum with acetate of lead—the most expensive way that could be devised. If an aqueous solution of the tribasic muriate or nitrate would answer as good a purpose—and *a priori* there is no reason why it should not do as well or better—it could be made at a much cheaper rate, especially by the alum manufacturer. For such a work the sulphate of alumina liquor made from pipe clay, needs no evaporation nor the addition of potash or ammonia sulphate. Being made quite weak and treated with prussiate of potash, it deposits its iron. The decanted liquor may be treated with sulphuret of sodium in excess, if one has no over sensitive neighbors; if otherwise, carbonate of soda may be used. The well washed and thoroughly drained precipitate being dissolved in a single equivalent of pure muriatic acid, can, for the sake of easy transportation, be dried down by a gentle heat, in stoneware pans, to a spongy, gumlike mass, which easily dissolves in water. Whether this or any more basic salt, actually possesses advantages over the mordant now in common use, it needs some one versed in all the niceties of calico-printing to determine; it lies out of my province. The tribasic chlorid has been tried on cotton by the formula for the madder style, with apparently good results; but experiments made by a novice, and remote from print works, are of little value.

Zirconium.—For want of material, I have been unable to make any examination of the salts of zirconium. But it so happens that there is enough on record so show that they are not unlike those of the other bases of the alumina class.

Berzelius describes a soluble "*sulfate bizirconique*," $\dot{Z}r_2\,\dot{S}_3$. He also says respecting a sesquibasic chlorid, $2Zr_2\,Cl_3 + \dot{Z}r + \dot{H}_{24}$, "Il se dissout facilement dans l'eau; et en évaporant cette solution

au bain-marie, on obtient le sel à l'etat gommeux. Il se dissout alors lentement, mais complétement, dans l'eau."

Under the head of the nitrates, he further states, on the authority of *Hermann*, "La liqueur peut ensuite dissoudre beaucoup d'hydrate zirconique pour former un soussel soluble dans l'eau. Ou peut aussi, pendant longtemps, ajouter de l'alcali, sans qu'il se forme de précipité."

Zirconia would appear, like the preceding hydrates, to have an inert allotropic form, for we are told that "L'hydrate zirconique précipité des dissolutions de la terre par l'ammoniaque caustique, est une matière blanche volumineuse et demi-gélatineuse, qui se dissout de suite dans les acides tant qu'elle est encore humide, mais qui, apres avoir été lavée à l'eau bouillante ou séchée, n'est plus dissoute que très lentement, même par les acides concentrés."

Cerium.—Ceric oxyd is remarkable for the sparing solubility of its sulphate. The pale sulphur-yellow basic sesquisulphate prepared by Bunsen's method, and not dried, was found to require a very large excess of sulphuric acid for its solution. By treating this acid sulphate with caustic soda, and dissolving the lilac-colored precipitate in a proper quantity of nitric acid, an orange-red, pure, normal nitrate was obtained. This gave with caustic soda or ammonia an oxyd easy to wash and readily soluble in weak nitric or chlorhydric acid; but not in formic, acetic, or fluorhydric acid. The lilac tint of the hydrate is suggestive of didymium, but there could be none present, for, by exposure to the air, the reddish precipitate absorbed carbonic acid and lost its color; and then, too, the basic salts made from it, whether soluble or insoluble, were yellow. The normal salts are mostly orange, and, like the salts of iron, are deeper colored when heated.

By direct union a soluble tribasic nitrate or chlorid can be produced with ease, but a further addition of the hydrate causes the deposition of a yellowish insoluble basic compound. In the way of neutralization, the nitrate, at least, can be made still more basic. It takes up enough carbonate of baryta to abstract five-sixths of the acid, and remains transparent. More of the carbonate causes a complete precipitation.

Ceric oxyd is, very likely, capable of existing in an inert state, but the circumstances under which it assumes such a condition have not been determined. A decided trace of sulphuric acid appears to destroy its activity.

Glucina.—Though glucina had, from its resemblance to alumina, long been reckoned among the sesquioxyds, its claims to such a place have latterly been called in question; and in some recent works on chemistry, its constitution is given as Be. O.

The principle now under consideration appears to draw a plain line of demarcation between oxyds of the magnesia and alumina types. On the one hand, it is a decided property of the neutral salts of the magnesia series, to afford precipitates on the addition of a very small quantity of alkali—such is the case with the protosalts of magnesium, zinc, iron, manganese, cobalt, nickel, and copper—also of cadmium, mercury, and tin. It has been shown, on the other hand, that salts of the alumina class are characterized by their capability of taking up a considerable quantity of their own, or of any stronger base, without the subsidence of any permanent deposit. Most of the protoxyds form only insoluble, pulverulent basic salts. The sesquioxyds enter into numerous, gum-like soluble, subacid combinations.

The examination of the glucina compounds was therefore entered upon with no little interest; because in determining on which side of the line this oxyd falls, there was reason for hoping to throw some new light on a still controverted subject.

With glucina obtained by the method of Berthier, it was found impossible to make a pure nitrate by crystallization. But from a solution of the imperfectly purified earth in sulphuric acid, it is easy to get a pure sulphate in large, compact, dimetric octahedral crystals, that admit of being washed and drained, and are quite permanent in the air. A nitrate free from alumina was procured by decomposing the recrystallized sulphate with nitrate of baryta. It crystallizes with some difficulty, and the crystals are very deliquescent so that they have to be dried over sulphuric acid. The quantity of glucina left after ignition, corresponds to $\ddot{B}e\,\ddot{N}_3\,\dot{H}_9$. This nitrate therefore differs from most others, in containing only three equivalents of water, instead of six, to one of nitric acid. Its point of fusion was found to be about 140° F. Melted and left alone, it began to crystallize when the inserted thermometer stood at 93°. On stirring, the temperature fell two or three degrees, and then rose quickly to 137°.

Ten grams of the crystals subjected to a steam heat for twenty hours, left a thick transparent mass, weighing six grams. This dissolved completely in water, and was found to contain but thirty per cent of dry nitric acid. Its composition, therefore, differed little from $\ddot{B}e_2\,\ddot{N}_3\,\dot{H}_9$. The same salt remains in solution when the normal nitrate is treated with an excess of carbonate of baryta in the cold, only enough baryta being taken up to neutralize half the acid. But by thorough boiling with carbonate of baryta, the glucina is all precipitated as a highly basic salt. This statement of the case may serve to reconcile the contradictory accounts of previous observers, some of whom assert that the earth is not thrown down by carbonate of lime, while others maintain that it is.

The nitrate gives with ammonia in excess, a hydrate in the active state. Indeed, it is not known that hydrate of glucina is ever passive with respect to acids, though that precipitated by boiling a diluted alkaline solution is said to be no longer soluble in alkalies.

By direct combination, the nitrate and the formiate, the chlorid, the bromid, and the iodid can be made nearly but not quite tribasic. By partial neutralization with ammonia, the nitrate may become fully tribasic, and remain perfectly clear.

The sulphate can be got almost tribasic, but the product will not bear large dilution.

Even the fluorid takes up some excess of base.

The acetate dissolves hydrate of glucina till it is rendered almost sexbasic, the solution being a little opalescent. This acetate dries down by spontaneous evaporation to transparent, shining scales. The tribasic salts get thick and sticky in dry air, but are too deliquescent to become hard.

If we suppose glucina to be a protoxyd, the gumlike compounds $\dot{B}e\,\dot{N}$, $\dot{B}e_2\,\bar{A}c$, would have the formulas $\dot{B}e_3\,\dot{N}$, $\dot{B}e_6\,\bar{A}c$, and would be entirely without parallel among the protosalts. But when there are pleistobasic ferric salts, polybasic chromic salts, hexbasic alumina salts, and tribasic ceric salts, we do not create any startling anomaly in ranking glucina among the sesquioxyds.

The slight solubility of glucina in hot alkalis, its behavior with ammonia salts, and the action of carbonate of baryta on its cold solutions, show that it is less acid and more basic in its character than alumina. Hence where the two earths occur united together, the alumina might be expected to play the part of an acid, and the glucina that of a base. Accordingly while we find in nature minerals of such constitution as $\dot{Z}n\ddot{A}l$, $\dot{M}g\ddot{A}l$, $\dot{F}e\ddot{C}r$, chrysoberyl is found to have a composition which satisfies the formula of the normal sesquisalts, $\dot{B}e\,\ddot{A}l_3$, just as well as that of the protosalts, $\dot{B}e\,\ddot{A}l$. Chrysoberyl, therefore, whose constitution has been pointed at as reconcilable only with the protoxyd theory, favors one view precisely as much as it does the other.

Berzelius has very justly called attention to the parallelism of the series of simple sulphates of glucina with those of alumina, iron, and chrome, as affording strong confirmation of the older view. And there is, in fact, but one plausible argument in favor of the protoxyd theory, and that is a negative one—the nonproduction of true alums with a glucina basis. Even this will have little force until regular cerium, zirconium, rhodium, and uranium alums can be shown. Besides, it is by no means a universal rule that the double salts of the sesquioxyds consist of one equivalent of a sesquisalt and one of a protosalt. Many of the sesquisalts deserve to be called *polygamous*. We are told that $\ddot{A}l\,\bar{S}_3$ unites

with either $\dot{M}g\bar{S}$ or $3\dot{M}g\bar{S}$;—Cr_2Cl_3 with 3KCl;—Fe_2Cl_3 with 2KCl;—Rh_2Cl_3 with KCl, or with $2NH_4Cl$, or with 3NaCl;—Al_2F_3, Zr_2F_3, and Fe_2F_3 with either 2KF or 3KF;—$\dot{C}r\bar{O}x_3$ with $\dot{K}\bar{O}x$, or $3\dot{K}\bar{O}x$, or $2\dot{N}a\bar{O}x$; and $\dot{F}e\bar{O}x_3$ with $3\dot{K}\bar{O}x$, or $3NH_4O.\bar{O}x$, or $3\dot{N}a\bar{O}x$. Why may we not then throw the double sulphate of glucina and potash among these variously conjugated double salts, and, in the question of atomic constitution, hold to the more positive guidance of the polybasic compounds?

Thorium.—As the double sulphate of thoria and potash contains one equivalent of sulphate of potash for each equivalent of sulphuric acid combined with the earth, this base was set down, by its discoverer, as a protoxyd. As to the correctness of such a conclusion, there is room for doubt, since none of the protoxyds—that of uranium perhaps excepted—loses its solubility in acids by exposure to a strong heat; while thoria is described as becoming passive by ignition, like most of the sesquioxyds. There is probably, too, an inert hydrate of thoria.

Berzelius says respecting the sulphate, "Si l'on ajoute de l'ammoniaque caustique à une dissolution neutre de sulfate thorique, il se forme un précipité qui ne tarde pas à disparaître, et qui paraît ainsi former un soussel soluble." This creates the suspicion of a polybasic character as belonging to the thoric salts, and it is very desirable that they should be examined with reference to this point. The impossibility of procuring any mineral containing thoria has prevented my following out the inquiry.

Uranium.—The general principle that normal salts contain one equivalent of acid for each equivalent of oxygen in the base, was shown by Graham to be quite at fault in respect to the phosphates; and since then it has been found that there are many polybasic acids. At present we know of but one inorganic subacid base. Those salts of uranic oxyd which are crystallizable and are generally allowed to be normal, contain but one equivalent of acid. Yet this base fully shares the most marked property of the sesquioxyds.

When ammonia is added to the sulphate, $\dot{U}\bar{S}$, the precipitate continues to redissolve till half the acid is neutralized. The clear liquid, it is true, at length becomes milky, and finally deposits a whitish sediment, but this is exceedingly small in amount. The chlorhydrate, $\dot{U}Cl\,H$, acts in the same way. With the nitrate we may go much further before there is any permanent precipitation.

In any solution, all the uranic oxyd cannot be thrown down by an alkali, unless a sufficient excess is added to form an alkaline uranite. And whether the pure hydrates obtained by indirect methods, are in the active state, so as to admit of the production of basic salts by direct combination, I have taken no pains to determine, not supposing that they would be.

But we can make pure soluble basic compounds in the way of precipitation and substitution. The normal sulphate treated cold with carbonate of baryta in excess, parts with two-thirds of its acid; and by decomposing this basic sulphate with a baryta salt, we may get a soluble tribasic nitrate, acetate, or chlorhydrate of uranium. These are of a somewhat deeper color than the normal solutions. The tribasic sulphate may be boiled without change, and after evaporation to dryness it redissolves completely in water.

The singularity of uranic oxyd then, is far from being accounted for by the uranyl theory, as this only gets rid of a strange sesquioxyd, by substituting a more anomalous protoxyd. For here it may be remarked—as in the case of glucina—that $\overline{U}_3\,\dot{N}$, $\overline{U}_3\,Cl.H$, are not unparalleled among sesquisalts, but $3\overline{U}.O.+NO_5$ and $\overline{U}.Cl+2\overline{U}O$ cannot be matched with any known protosalts.

Some have cited the precipitation of metallic silver from the nitrate by protoxyd of uranium, as confirmative of the theory. But if this proves anything, it proves too much, for as protoxyd of iron also precipitates metallic silver, we should have to admit the existence of *ferryl*, and probably, too, of *chromyl* and *stannyl*.

Though there are such compounds as $\dot{S}n.Cl.H.$, and $\dot{F}e+2Fe_2Cl_3$, and $\dot{F}e_2+Fe_2Cl_3$, the occurrence of bibasic and tribasic nitrates, shows the impropriety of writing the formulas as $Sn.O.Cl_2$, $-Fe_2O.Cl_2$—Fe_2O_2Cl. And why chlorhydric acid does not change sesquioxyd of uranium to sesquichlorid, is not made manifest by giving such a formula as U_2O_2Cl.

However convenient it might be, for some purposes, to have all the bases reduced to protoxyds—by compounding atoms as U_2O_2O, or by dividing atoms as $Fe\frac{1}{2}O$.—the great difference in chemical relations, between the protoxyds and the higher oxyds, seems to be a grand obstacle in the way.

The uranyl theory fails of completely answering the purpose for which it was framed; and would it not be well to drop uranyl from scientific works, until there is some positive proof of its existence, or till the hypothesis can be of some real service?

It is not many years since phosphoric acid stood alone in its class. And as the field of inorganic chemistry is more fully explored, it may yet be found that there are other subacid bases besides uranic oxyd.

ART. XXIV.—*Zoology of Hayti;* by Dr. D. F. WEINLAND.*

A FEW weeks since I returned from nearly half a year's sojourn on the southwestern neck of that beautiful mountain-island, (this is the meaning of the Indian name Hayti,) and I wish to communicate to my scientific friends some of my impressions and observations,† while they are fresh in my mind, even if they should lack the stamp of elaboration.

I shall speak now of the organic life of the sea-shore, and since this depends upon the geological formation of the coast, and upon the nature of the sea, these subjects will first be introduced.

1. *The Sea-shore.*

The northern shore of the southwestern neck of Hayti is mostly *côte de fer*, that is, an iron-bound coast. There are but few small sandy bays, which serve as landing-places for the fishing boats, and near them are generally found huts of fishermen, or a small village.

The rock which bounds all the rest of the coast is a hard brittle limestone, formed very generally of a conglomeration of Madrepores and other corals, as Astrææ, Mæandrinæ, Milleporæ, etc., and of various kinds of shells, cemented with a mass of smaller and formless lime-particles, the powdered particles of the same corals and shells. This rock is full of pores and roundish cavities with sharp edges, perhaps the places where softer shells or fragments of corals have been washed out by the erosion or attrition of the water, or knocked out by corals, thrown up in the stormy winter season of the furious north wind. The species of corals and shells which enter into the composition of this rock, I found nearly all alive in the adjoining sea. Some of them, however, have disappeared from among the living; others are dying out, and are now very rarely found, though common in the earlier portions of the present period; for they exist in great quantities in the rock at the depth of a few feet. Such animal remains enclosed in rock, yet belonging to species now living, or to species now extinct, but which lived in the earlier ages of this period, together with species now living, we are accustomed to call modern fossils. They are the more interesting because they show how, without any remarkable revolution of our globe, certain species of animals gradually die out.

The same rock, composed of modern fossils and their detritus, I found in the interior mountain regions of the island, about

* From the proceedings of the Boston Society of Natural History.

† Most of these observations were made in company with my friend Mr. Edward Habich of Boston, a member of our Society, on our daily walks along the sea-shore, or during our excursions up the rivers or back in the forests of the interior.

thirty miles from the sea-shore, and at a height, as I should judge, of at least one thousand feet above the present level of the sea. Indeed, the first, that is, northernmost, ridge of mountains which runs along that northern sea-shore of Hayti, from east to west, is crowned with large layers or broken masses of this same kind of rock, which being, as stated above, a formation of the present geological period, goes far to show that this whole ridge has been raised in this present period. Thus the existence of the greater part, and the configuration of the whole of the southwestern neck of the island of Hayti is of comparatively recent origin.

Two questions at once suggest themselves here, *Whether the formation of the same rock, and whether the elevation of the land, are going on at the present time.* That the former, the formation of the same limestone rock, is really in progress at the present day, seems to be evident in some places, where the whole bottom of the sea near the shore, at a depth of from one to five and six feet below low-water mark, is, as it were, a flat pavement of the same kind of rock. Crust-building corals, as Porites, Mæandrinas, Siderastræas, etc. live upon it, and in the interstices of these are thrown up from below dead shells, broken Millepores, Madrepores, and Astræans. By the powerful action of the waves on the shallow bottom, these remains are broken and ground upon each other, and their form is lost.

The lime powder which results from this pulverizing action furnishes the cement which fills the shells and unites the pieces into one solid mass, *Maçonnerie bon Dieu* (God's Masonry) as the negroes of the French colonies call it. In consideration of these facts the first part of our question may be answered in the affirmative.

But whether the whole coast is constantly and gradually rising, (as we know is the case with the coast of Sweden,) or whether those different layers of that submarine pavement have been thrown up at various periods, by sudden volcanic agencies, I am at a loss to decide from my own observations. I will only state that the layers which now lie just above low-water mark, are (for instance, in some places in the neighborhood of Jeremie) quite undisturbed banks, running in a plain parallel to the level of the sea. This seems rather to favor the idea of a gradual rising than of a sudden upheaving, for the latter would be more likely to fracture the layers and to change their original horizontal position into an angle towards the horizon.

I conclude, from the information afforded me, that this limestone formation must extend over the whole northern part of Hayti, from its western cape (Tibouron) to the neighborhood of Port-au-Prince. Further, the rocky part of the sea-shore of Barbadoes, Maria Galante, of Grand-terre in Guadaloupe, of Antigua,

St. Bartholomew, St. Martin, Arguilla, and Santa Cruz, seems to be of the same composition and age. I should judge so, also, from an account of William Maclure, published just forty years ago in the Journal of the Academy of Natural Sciences of Philadelphia, vol. i. p. 134, *et seq.* Further also, the honeycomb limestone of Jamaica is the same rock, according to a communication of my friend Dr. Hyde,* who lived in that island for many years.

I have not yet had an opportunity to look for other geological reports of the Antilles. I suppose, however, that this is the same limestone formation, which the negroes in Guadaloupe very appropriately call "God's masonry," and which is so evidently a formation of modern time, since it encloses instruments made by man, and even those once celebrated, supposed fossil human skeletons.

If we want a name for the Haytian limestone described above, we might call it the "modern Coral-rag," for had it not been for the difference in the fossil remains, I should have recognized it as exactly the same limestone, which forms those steep, porous rocks of the so-called rough Alps of Southern Germany, between the Danube and Rhine. Indeed, it was not a slight pleasure for me to see here clearly, how those old rocks of my home must have been formed in their time, millions of years ago, when Southern Germany was yet an island not much larger than Hayti, having a warm climate, and surrounded by a warm ocean; and presenting, all along the coast, the same banks of corals; and in the cavities of these rocks the Cidarites, which abounded then, and of which I found one species alive in Hayti. But this also is so scarce as to show that its days have passed.

2. *The Sea of Northern Hayti.*

Beyond the formation of the coast there are some features connected with the sea, which borders upon the northern side of that island, which are of the greatest importance to its animal and vegetable life.

1. The great respiration of the ocean, the ebbing and flowing of the tide, hardly touches that coast. Neither the native fishermen along the coast, nor the American captains in the harbor speak of high and low water there. The great tide-wave is not only broken by the wall of islands in front of the Mexican Gulf, but, perhaps, is even neutralized by a continual current, which runs from east to west all along the northern shore of Hayti.

* Dr. J. S. Hyde, of New England, a zealous and experienced conchologist by whom were collected many of the Jamaica land-shells, which were described by the late Prof. Adams, tells me that he found this limestone, particularly in the northern part of that island. He noticed it for the great number of Cyclostomas which live in the cavities.

2. All the motion of the sea on that shore depends upon the wind. Its agencies are twofold; first, *the daily change of sea and land wind*, the former beginning to blow in the morning about eight o'clock, the latter in the evening between six and nine. The latter is much more constant, and being also more powerful, it depresses, every evening, the level of the sea all along the coast from one to two feet. But there is, secondly, another, a *yearly change of the winds*, viz.: a prevailing northerly wind in winter, particularly in December, January, and February, and a prevailing southerly wind in summer. This great change produces this effect, that in the season of the North, as they call it there, the level of the sea is constantly, on the average, eight feet higher than in summer.

How much this change bears also upon the organic life of the sea coast, is evident. I will only state that during the last week of May and the first of June, in one place not larger than an acre, more than a hundred Actiniæ and Holothuriæ died, because left upon dry land; not to speak of the thousands of other animals, fishes, echini, etc., and of sea-plants which died in those natural basins near the sea, where the water, cut off from the refreshing ocean, was overheated by the nearly perpendicular rays of the tropical sun. The rising of the land from the waves, the same that we know took place repeatedly in the great epochs of the history of our globe, and which, as has well been said, "brought death among the sea tribes in one universal desolation"—the same we see now on the northern shore of this island, repeated annually with the change of the winds; and though on a smaller scale, yet destroying hosts of living organisms. Moreover, in that stormy sea of the North, the whole bottom of the ocean, all along the shore, at more than five fathoms depth, is swept, and not only all the dead remains but many living shell-fishes, and large blocks of corals, are dashed against the iron-bound coast and thrown up on dry land. This is the season dreaded equally by the Haytian coasters and the merchant vessel in the harbor. The former, when overcome by a dark, stormy night, without a compass, an instrument unknown to them, are driven helpless along the shore, and their small boats frequently thrown against the rocks. The latter, the merchant vessel, drags its anchors on the moving bottom of the sea (called *rade marée*) and runs ashore.*

Besides the motion of the sea, there is one circumstance more worthy of notice, as bearing upon the organic life of this sea-shore. It is the *chemical composition of the sea-water*. The sea-

* In the harbor of Jeremie, which is not protected against this north wind, two vessels ran ashore at one time during one of the last winters. This occurs nearly every year.

water contains, at this distance (about eighteen degrees) from the equator, the greatest amount of salt in solution; more than the water near New England, and a good deal more than the sea immediately under the equator. This remarkable fact has been shown by Linz, a German scientific traveller on his voyage round the world.* The rivers of the northern shore of Hayti are not large enough to exert an extensive influence upon the composition of the sea-water, even in the immediate neighborhood of their mouths, and, moreover, they are generally barred up by sand-banks during a great part of the dry season. These sand-bars prevent again a large pouring in of sea-water into the river, and thus the river water is quite fresh and sweet in the immediate neighborhood of the sea, so much so that vessels take in their drinking water there. But notwithstanding this, (and it is an intereresting physiological fact,) I found relatively more sea-fishes going up annually from the sea into these rivers, than ascend the German rivers; showing how flexible their nature must be to bear the sudden change in the saltness and density of the water, when passing from that deeply saline ocean into fresh water. The case is different with those sea-fishes of New England and Germany which enter rivers; they have always to pass through brackish water, and thus the change is effected gradually.

ART. XXV.—*On the Formation of Continuous Tabular Masses of Stony Lava on Steep Slopes; with Remarks on the Mode of Origin of Mount Etna, and the Theory of "Craters of Elevation;"* by Sir CHARLES LYELL, F.R.S., &c.†—(Abstract.)

THE question whether lava can consolidate on a steep slope, so as to form strata of stony and compact rock, inclined at angles of from 10° to more than 30°, has of late years acquired considerable importance, because geologists of high authority have affirmed that lavas which congeal on a declivity exceeding 5° or 6° are never continuous and solid, but are entirely composed of scoriaceous and fragmentary materials. From the law thus supposed to govern the consolidation of melted matter of volcanic origin, it has been logically inferred that all great volcanic mountains owe their conical form principally to upheaval or to a force acting from below and exerting an upward and outward pressure on beds originally horizontal or nearly horizontal. For in all such mountains there are found to exist some stony layers dipping at 10°, 15°, 25°, or even higher angles; and according to

* See Humboldt's Kosmos, i, p. 320, where we find also the reason for this remarkable fact.

† From the Proceedings of the Royal Society of London for June 10, 1858.

the assumed law, such an inclined position of the beds must have been acquired subsequently to their origin.

After giving a brief sketch of the controversy respecting "Craters of Elevation," the author describes the results of his recent visit (October, 1857) to Mount Etna, in company with Signor Gaetano G. Gemmellaro, and his discovery there of modern lavas, some of known date, which have formed continuous beds of compact stone on slopes of 15°, 36°, 38°, and, in the case of the lava of 1852, more than 40°. The thickness of these tabular layers varies from 1½ foot to 26 feet; and their plains of stratification are parallel to those of the overlying and underlying scoriæ which form part of the same currents. The most striking examples of this phenomenon were met with—1st, at Aci Reale; 2dly, in the ravine called the Cava Grande near Milo, where a section of the lava of 1689 is obtained; 3dly, in the precipice at the head of the Val di Calanna, in the lava of 1852–'53; and 4thly, at a great height above the sea near the base of the Montagnuola.

Sir C. Lyell then alludes to the extraordinary changes which had taken place in the scenery of the Valley of Calanna and the Val del Bove since his former visit to Mount Etna in 1828—changes effected by the eruption of 1852–'53, one of the greatest recorded in history. A brief account is given, extracted from contemporary narratives and illustrated by a map, compiled with the assistance of Dr. Giuseppe Gemmellaro, of the course taken in 1852–'53 by various streams of lava, some of them six miles in length, flowing during nine successive months from the head of the Val del Bove to the suburbs of Zafarana and Milo. The present aspect of this lava-field, parts of it still hot and emitting vapor, and the numerous longitudinal ridges and furrows on its surface are described. As to the origin of these superficial inequalities, the author inquires whether they may be due to the flowing of lava in subterranean tunnels, or whether they be anticlinal and synclinal folds caused by fresh streams pouring over preceding and half-consolidated ones, so that these last may be bent and crumpled by the newly superimposed weight, like soft yielding ground on which a railway embankment has been made. The cascade of the lava of 1852, descending a precipitous declivity 500 feet high, called the Salto della Giumenta, and the stony character of the layers which encrust the steep slope at angles of more than 35° and even 45°, are commented upon. This lava has overflowed that of 1819, which congealed on the same precipice; and it is shown that in such cases the junction-lines separating two successive currents must be obliterated, the bottom scoriæ of the newer dovetailing into the upper scoriæ of the older current.

The structure of the nucleus of Etna, as exhibited in sections in the Val del Bove, is next treated of, and the doctrine of a double axis is deduced from the varying dip of the beds. The strata of trachyte and trachytic agglomerate in the Serra Giannicola seen at the base of the lofty precipice at the head of the Val del Bove are inclined at angles of 20° to 30° N. W., *i. e.*, towards the present central axis of eruption. Other strata to the eastward (as in the hill of Zoccolaro) dip in an opposite direction, or S. E., while, in a great part of the north and south escarpments of the Val del Bove, the beds dip N.E., or N., and S.E., or S., respectively. There is, therefore, a quaquaversal dip away from some point situated in the centre of the area called the Piano di Trifoglietto. Here a permanent axis of eruption may have existed for ages in the earlier history of Etna, for which the name of the axis of Trifoglietto is proposed, while the modern centre of eruption, that now in activity, may be called the axis of Mongibello. The two axes, which are three miles distant the one from the other, are illustrated by an ideal section through the whole of Etna, passing from west to east through the Val del Bove, or from Bronte to Zafarana. Touching the relative age of the two cones, it is suggested that a portion only of that of Mongibello may be newer than the cone of Trifoglietto. The latter, when it became dormant, was entirely overwhelmed and buried under the upper and more modern lavas of the greater cone. This doctrine of two centres, originally hinted at by the late Mario Gemmellaro, had been worked out (unknown to Sir C. Lyell at the time of his visit) by Baron Sartorius von Waltershausen, and has since been supported in the fifth and sixth parts of his great work called "The Atlas of Etna," both by arguments founded on the quaquaversal dip of the beds as above explained, and by the convergence of a certain class of greenstone dikes towards the axis of Trifoglietto. Von Waltershausen has also shown, that the superior lavas and volcanic formations crowning the precipices at the head of the Val del Bove, from the Serra Giannicola to the Rocca del Corvo inclusive, are unconformable to the highly inclined beds in the lower half of the same precipice, the superior beds being horizontal, or, when inclined, dipping in such directions as would imply that they slope away from the higher parts of Mongibello.

According to Sir C. Lyell, the alleged discontinuity between the older and modern products of Etna is, in truth, only partial, and almost confined to that flank of the mountain, where its physical geography has been altered by three causes: 1st, the interference of the two foci of eruption (Trifoglietto and Mongibello); 2ndly, the truncation of the cone of Mongibello; and 3rdly, the formation of the Val del Bove. The truncation of the mountain here alluded to is proved by the remains of the upper

portion of a cone, traceable at intervals around the borders of an elevated platform between 9,000 and 10,000 feet high. These remains bear the same relation to the highest and active cone, nearly in the centre of the platform, which Somma bears to Vesuvius. The manner in which the north and south escarpments of the Val del Bove diminish in altitude as they trend eastward from the high platform, is appealed to as showing that the great lateral valley had no existence till after the time when Mongibello had attained its fullest development and height.

The double axis of Etna is then compared to the twofold axis of the island of Madeira, as inferred from observations made in 1854 by M. Hartung and the author. In that island the principal chain of volcanic vents, running east and west, and thirty miles long, attains at one point a height of 6000 feet. Parallel to it, at the distance of two miles, a shorter and lower secondary chain once existed, but was afterwards overflowed and buried to a great depth by lavas issuing from the higher and dominant chain. The space between the two axes, like the space which separated the two cones of Etna, has been filled up with lavas in part horizontal. On the north side of Madeira, as probably on the west side of Etna, where no secondary centre of eruption interfered with the slope of the volcanic formations, and where the order of their succession and superposition is uninterrupted, there occur, both in Madeira and Etna, deep crateriform valleys (the Curral and the Val del Bove) intersecting the products of the two axes of eruption.

In concluding this part of his memoir, Sir C. Lyell observes, that the admission of a double axis, as explained by him, is irreconcileable with the hypothesis of "craters of elevation;" for it implies that, in the cone-making process, the force of upheaval merely plays a subordinate part. One cone of eruption, he says, may envelop and bury an adjoining cone of eruption; but it is obviously impossible that one cone of upheaval should mantle round and overwhelm another cone of upheaval.

An attempt is then made to estimate the proportional amount of inclination which may be due to upheaval in those parts of the central nucleus of Etna where the dip is too great to be ascribed exclusively to the original steepness of the flanks of the cone. The highest dip seen by the author was in the rock of Musarra, where some of the strata, consisting of scoriæ with a few intercalated lavas, are inclined at 47°. Some masses of agglomerate and beds of lava in the Serra del Solfizio were also seen inclined at angles exceeding 40°. Some of these instances are believed to be exceptionable and due to local disturbances; others may have an intimate connection with the abundance of fissures, often of great width, filled with lava, for such *dikes* are much more frequent near the original centres of eruption than at

points remote from them. The injection of so much liquid matter into countless rents may imply the gradual tumefaction and distention of the volcanic mass, and may have been attended by the tilting of the beds, causing them to slope away at steeper angles than before, from the axis of eruption. But instead of ascribing to this mechanical force, as many have done, nearly all, or about four-fifths of the whole dip, Sir C. Lyell considers that about one-fifth may, with more probability, be assigned as the effect of such movements.

The alleged parallelism and uniformity of thickness in the volcanic beds of the Val del Bove, when traced over wide areas, is next considered, and the author remarks that neither in the northern nor southern escarpments of the great valley, could he and his companion verify the existence of such parallelism. Examples of a marked deviation from it are given, both in cliffs seen from a distance, and in others which were closely inspected, even in cases where these last, when viewed from far off, appeared to contain regular and parallel strata.

The direction and position of the dikes in the Val del Bove is then spoken of, both in reference to the two ancient centres of eruption, and to the question of the altered inclination of the intersected beds. In regard to the arrangement also of the lateral cones of eruption, the question is entertained, whether they are disposed in linear zones, or are in some degree independent of the great centre of Mongibello.

The origin of the Val del Bove has been variously ascribed to engulfment, explosion, and aqueous erosion. Admitting the probable influence of the first two causes, the author calls attention to the positive evidence in favor of aqueous denudation afforded by the accumulation of alluvium in the lower country at the eastern base of Etna between the Val del Bove and the sea. This rudely stratified deposit, 150 feet thick and several miles in length and breadth, contains at Giarre, Mangano, Riposto and other places, fragments, both rounded and angular, of all the rocks, ancient and modern, occurring in the escarpments of the Val del Bove, and it implies the continuance there for ages of powerful aqueous erosion. The alluvium of Giarre is therefore supposed to bear the same relation to the Val del Bove that the conglomerate of the Barranco de las Angustias bears to the Caldera of Palma in the Canaries; and those two crater-like valleys, as well as the Curral of Madeira, are believed to have been shaped out in great part by running water. But to render this possible, the suspension, for a long period, of the outpouring of lava on the eastern flank of Etna must be assumed.

The author fully coincides in the generally received opinion that the accessible parts of Etna are of subaërial origin, and refers to some fossil leaves presented to him by MM. Gravina and

Tournabene, of Catania, as well as to others collected by himself *in situ*, from the volcanic tuffs of Fasano and Licatia, which have been determined by Prof. Heer to belong to terrestrial plants, of the genera Mytle, Laurel, and Pistachio, now living in Sicily. These tuffs, together with the general mass of Etna, repose on marine strata of the newer Pliocene period, in which 150 species of shells, nearly nine-tenths of them identical with species now existing in the Mediterranean, have been found. A very modern marine breccia, with shells of living species extending to the height of thirty feet on the coast along the eastern base of Etna, was pointed out to the author by Signor G. G. Gemmellaro near Trezza, and in the island of the Cyclops. The same formation has been traced together with lithodomous perforations by Dr. Carlo Gemmellaro and Baron v. Waltershausen along the seashore as far north as Taormina, beyond the volcanic region of Etna. From these and other data, enlarged upon in the memoir, Sir C. Lyell concludes, first, that a very high antiquity must be assigned to the successive eruptions of Etna, each phase of its volcanic energy, as well as the excavations of the Val del Bove, having occupied a lapse of ages compared to which the historical period is brief and insignificant; and secondly, that the growth of the whole mountain must nevertheless be referred geologically, to the more modern part of the latest Tertiary epoch.

Art. XXVI.—*Geographical Notices.*—No. III.

The Telegraph Plateau.—Remarkable Discrepancies in the Published Statement of Soundings.—In a recent letter to Dr. Petermann, published in his *Mittheilungen* (Dec. 1857, p. 507), Lieut. Maury presents a statement in respect to the so-called "Telegraph Plateau," and the soundings upon it by Lieut. Berryman, U. S. N., from which we propose to make some extracts.

As the subject is of general interest, we give a brief account of the Atlantic soundings referred to, before quoting Lieut. Maury's remarks.

In July, 1856, Lieut. Berryman, U. S. N., acting under the authority of the Secretary of the Navy, left New York in the government propeller "Arctic" for the purpose of making soundings between Newfoundland and Ireland, and "ascertaining if possible the practicability of laying a telegraphic wire or cable between America and Europe." From the official report it appears that he left St. John's July 31, and reached Queenstown Aug. 22, after having effected, at intervals of different extent, numerous soundings, "all attended with complete success." Returning he left Queenstown Sept. 10, and arrived at St. John's

Sept. 30, having sounded on this trip "only in the intervals unavoidably neglected in going out.'

Upon his return no doubts were entertained of the feasibility of laying the cable. In fact Lieut. Berryman remarks, "nothing seems easier, now that the character of the bottom is known and the depth ascertained to a nicety which was hardly ever expected." "The incalculable usefulness" of these soundings is referred to in the annual report of the Secretary of the Navy with avowed pride, and the enterprize and accuracy of Lieut. Berryman are commended in corresponding terms.

On the report of these soundings the projectors of the transatlantic telegraph appear to have relied in deciding upon the course in which an attempt should be made to lay their cable. Their official statement contains a sketch of the plateau derived from the soundings of Lieut. Berryman. "This submarine ledge," says the report of the company, "has been very accurately examined by soundings, and it is found that it is nowhere deeper than 12,000 feet (a trifle more than two miles). It dips down slightly from either coast, reaching its greatest depression in mid ocean; but the slope is a very gradual and easy one, and the surface is devoid of all abrupt irregularities."

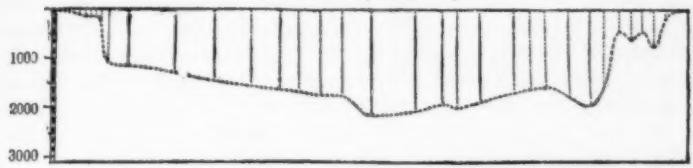
The appended sketch, said to be derived from Berryman's survey, is not only free from undulations remote from the coast, but represents an easy gradual inclination from both shores outward. The measurements thus accepted and endorsed have induced far and wide the belief that between Cape Race and Cape Clear, there is a smooth surface, of moderate depth, "designed by Providence" to connect by electrical sympathies the Old World and the New. Hence the name "Telegraph Plateau."

But all the apparent certainty which is said to have mapped the surface of this plateau "with considerably greater accuracy than the interior of the continents of Africa and Australia," has been set aside by recent revelations. Lieut. Maury's letter, above referred to, which acknowledges this unexpected disclosure, is accompanied in the *Mittheilungen* by three sketches of sections of the plateau, derived from identically the same soundings but marvelously unlike, as will be seen in the copy of them which is herewith presented.

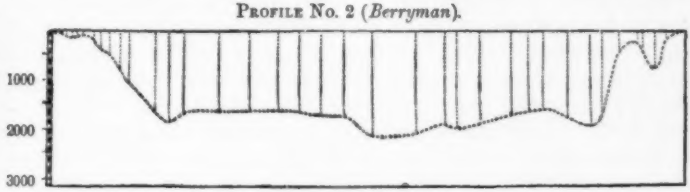
For the explanation of these diagrams it is necessary to remark that the line of soundings extended from the coast of Newfoundland to Ireland. Each sounding is marked by a perpendicular line. The reported bottom of the plateau is indicated by the dotted line running from east to west. In the third diagram the different soundings obtained in going out and in coming back near the Newfoundland coast are indicated. The perpendicular lines are exaggerated one hundred times in proportion to the horizontal.

In respect to these sketches Lieut. Maury writes as follows: "Lieut. Berryman sent over from Ireland to the Navy department a vertical section or side view of the depth of water upon this plateau (profile No. 1).

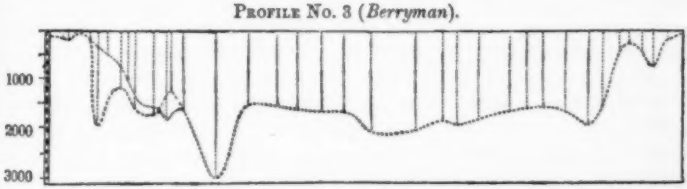
PROFILE No. 1 (*Berryman*).



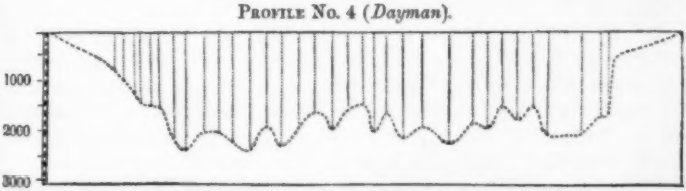
PROFILE No. 2 (*Berryman*).



PROFILE No. 3 (*Berryman*).



PROFILE No. 4 (*Dayman*).



The numbers 1000, 2000, 3000, indicate the depth in fathoms.

"Upon his return to the United States certain differences were pointed out between the depths which the profile indicated and the original soundings as they are stated in the abstract log of the ship. Hereupon he presented a second profile as the correct one (profile No. 2). But upon its examination it was found that neither of the two agreed with the depths which are stated in the abstract log from day to day as the soundings were accomplished (profile No. 3).

"The method employed in the deep soundings was evidently faulty. He had employed "Massey's Indicators" without hav-

ing corrected their errors and without having taken precautions to determine the rapidity of the running out of definite lengths of line, by which errors could have been avoided. Moreover differences appeared every time that two soundings were made nearly on the same place, one in going out and the other in coming back, as was several times the case. For example, between the last sounding, 120 fathoms upon the bank of Newfoundland, and the meridian 43° W., he sounded seven times on the way to Ireland and six times on the way back. The different depths thus obtained are indicated by a second dotted line upon the third profile. The whole work proved, therefore, worthless, and must be done over."

Soundings were made by Lieut. Dayman, R. N., in the British ship "Cyclops," in the summer of 1857, before the unsuccessful attempt to lay the cable. A section illustrating the results which he obtained is published in connection with the three sections of Berryman (profile No. 4). "It shows," says Lieut. Maury, "remarkable undulations of the bottom between Ireland and Newfoundland which continue about half the entire distance. Here the deep and shallow places alternate with such striking regularity that the question suggests itself whether this wave-shaped bottom is not to be ascribed rather to an accidental error or to the different manipulations of those who were charged with the soundings than to the real physical configuration."

It is not surprising that the statements of this letter should call forth both criticism and satire. The discrepancies in the reported profiles of Lieut. Berryman, and their great dissimilarity to the profile of Lieut. Dayman occasions the following remarks in the *Zeitschrift für allgemeine Erdkunde*, 1857, p. 77. After quoting a part of the above letter of Lieut. Maury, the article continues:—"In the third reading [of Berryman] occurs the enormous depth of 3000 fathoms which makes such a hazardous breach in the idea of the 'telegraph plateau,' and that too in the very place where the sea, according to the first profile, ought to be only 1400 fathoms deep.

"But however much these three sketches differ from one another, they bear to the profile made from Lieut. Dayman's soundings and particularly to the idea of a 'plateau' no greater resemblance than a ploughed field to a parquet floor. Dayman's profile shows such a stubborn (*hartnäckige*) series of heights and depths that the very idea of a plateau is put to ridicule. It represents, we are sorry to say, exactly in the place where, according to the third distillation of Lieut. Berryman's sketches, the greatest depth of 3000 fathoms should be, a fine mountain, which elevates itself more than 2000 feet above the adjacent valleys to the east and west.

"Lieut. Maury naturally ponders with shakings of the head 'the remarkable undulations' of the bottom which this profile indicates."

Quoting then his hypothesis as given above, the article goes on: "But since the different peaks given upon the sketch are neither of approximatively the same height and are not equally distant from one another, we are not in a position to recognize in the alternation of heights and depths a 'remarkable regularity.' The profile presents indeed only an alternation of heights and depths, but if the idea of a plateau is abandoned this is less remarkable than natural."

The article of Prof. Trowbridge, of the United States Coast Survey, printed in this number of the Journal, (p. 157,) discusses in a thorough manner the elements of error in the soundings of Berryman and Dayman. Its concluding remarks demand repetition in this connection.

"With all its imperfections, however, Massey's indicator furnishes better results when carefully used, than the method of measuring the depth by the line out; and for this reason I think the soundings of Lieut. Berryman where he used the indicator, on the line of the Atlantic telegraph, are much nearer the truth than those of Lieut. Dayman.

"In both cases the probable errors are very large, amounting in many instances, I think, to several hundred fathoms.

"The idea of a 'Plateau' existing between Newfoundland and Ireland is not warranted it seems to me by any observations that have yet been made. The range of errors may be as great as 500 fathoms, which would admit of the existence of a submarine mountain on this line, half as high as Mount Washington. A true section of the Atlantic can only be determined by improved modes of sounding. Since from the preceding discussion we may be warranted in the conclusion that it is practically impossible to determine the greatest depths of the ocean by the methods now in use."*

New Explorations in Central Africa.—The European Journals announce another expedition into Central Africa. Its projector is Baron von Krafft, whose intention is to visit the interior of Soudan. He has embarked for Tripoli, and will probably take the route from Ouargla to Djebel Hoggar, a route which has never been followed by Europeans.

A letter from Baron Krafft to Humboldt, dated April 10, 1858, from Algiers, expresses the desire of the author to continue the

* The following errata in the paper of Prof. Trowbridge were received after it had gone to press.—Eds.

Page 158, 1st line from top, for "95" read "96."—Page 169, in the formula and in the second line below it, for "v" read "V."—Page 170, 3d line from bottom, after "as much as" insert "one-fourth of."

discoveries of Dr. Barth, so far as limited resources will allow. He will travel in the incognito of a Turkish physician, provided with allopathic and homœopathic medicines, and attended by an Algerian Moor, who is acquainted with the native method of practice. An aneroid barometer, several thermometers, two compasses, a chronometer, a sextant, and a telescope, are the instruments which he carries. He intends, however, to devote himself chiefly to such observations as can be made without his instruments, to collect minerals and plants, to inquire into the trade, language, history and literature of the people whom he visits, and to determine with the greatest possible accuracy the various routes of caravans and their chief stopping places.

The route of travel which Baron Krafft has marked out for himself is from Tripoli to Ghadames, and thence to Aïn Salah and Timbucktoo. Then he proposes to visit Lake Tsad, and afterwards to go according to his strength and means, either east to Wara and Dar Fur, or north to Bilma, Seggadem and Murzuk.

Möllhausen's Journey West of the Mississippi.—Möllhausen's *Tagebuch einer Reise vom Mississippi nach den Küsten der Sud-see*, (Diary of a Journey from the Mississippi to the Coast of the Pacific,) referred to in the May number of this Journal, has been published in Leipsic, in a quarto volume of about five hundred pages, illustrated by thirteen prints in oil colors, ten wood cuts, and one map. The mechanical execution of the work is of the highest order. The author, it will be remembered, was employed in the Pacific Railroad Surveys, as draughtsman to the expedition commanded by Lieutenant Whipple, whose report illustrated by some of Möllhausen's sketches forms the second volume of the series.

The volume now before us is an important contribution to our knowledge of the ethnography of the regions which were visited. It is introduced to the public by a preface from Alexander Von Humboldt.

The author, in his concluding page, expresses his intention to accept an invitation to join the Colorado expedition, now in the field under the command of Lieutenant Ives.

Rawlinson's Herodotus.—The first and second volumes of a new translation of Herodotus have just appeared in England. The work is entitled: *The History of Herodotus, a new English Version, edited with copious Notes and Appendices, illustrating the History and Geography of Herodotus, from the most recent sources of information; and embodying the chief results, Historical and Ethnographical, which have been obtained in the Progress of Cuneiform and Hieroglyphical Discovery;* by George Rawlinson, M.A., assisted by Col. Sir Henry Rawlinson, K.C.B., and Sir J. G. Wilkinson, F.R.S. Vols. 1 and 2; with maps and illustrations.

Its value consists not mainly in the new English version, but in the copious notes which illustrate every page, the introductory chapters by the editors and the extended essays which conclude the volumes.

Two of these essays appended to the first volume present a clear and concise review of what is known in respect to the physical geography of western Asia. The second essay is devoted to Asia Minor, and the ninth, which extends through over fifty pages, is devoted to Mesopotamia and the neighboring countries. The eleventh essay discusses the ethnological affinities of western Asia. Besides these essays of a geographical character, there are others on historical and religious topics likewise full and elaborate. Vol. 2 is chiefly upon Egyptian history. One of its essays is on the Topography of Babylon.

D. C. G.

ART. XXVII.—*On Chinese Poisons;* by D. J. MACGOWAN, M.D.

IN consequence of the atrocious attempt of the Cantonese to poison the foreign community at Hongkong, applications have been made to us from various quarters for information on poisons known to the Chinese. An investigation of Chinese toxicology would require much time, and special study, which we despair of being able to devote to that interesting subject. In default of presenting anything of value to the scientific inquirer, we submit for the perusal of the general reader the limited information we possess on Chinese poisons. From the period of the Han dynasty to the present day poisoned arrows have been employed, both in the chase and in warfare; less, however, by the Chinese proper than by the so-called aborigines or Miautsz. In the hands of the latter, they are formidable weapons. Instant death is inevitable from the slightest abrasion. The Chinese possess no agents for counteracting the poisons of the hill tribes; the *Pun Tsau* states that these Inner Barbarians apply borax sometimes with success to poisoned wounds; and it is commonly reported that for their various virulent poisons they possess perfect antidotes.

We are acquainted with only one of the *inoculating* poisons of the Chinese—a watery extract of the root of *tsau-wu*—a perennial creeper found on the hills of the central provinces. Its botanical character, as well as its precise physiological action, we have yet to ascertain. Its active principle appears to be highly volatilizable, and great exactness is needed in preparing it. Small animals are kept in readiness for testing the strength of the extract; they are punctured with a point charged with the poison, and when its virulence is sufficient to occasion instant death, it is

boiled no longer. A native physician who saw it prepared by the hunters of the adjacent district of Funghwa, states that sometimes they prick their arms to let blood flow to the wrist, and after carefully wiping the part near the wound, apply some of the pasty extract to the lower end of the line of blood, which it rapidly blackens through its whole length; and it is affirmed, that were the continuity with the incision unbroken the morbific action of the subtile agent would penetrate the wound and prove quickly fatal. It is sometimes applied to the tongues of the unwary as a practical joke—when it occasions a keen sensation of formication. The dried root is administered where the nerves of motion are impaired. The Funghwa hunters traverse in winter the mountainous regions of Chihkiang in pursuit of tigers that are sometimes taken by being pierced with arrows, the necks of which are bound with filaments of cotton saturated with the poison; at other times, springs charged with these arrows are adjusted near the lair of the animal for his destruction. When a limb is struck the beast writhes awhile before expiring, but when wounded in the body, he leaps forward, staggers and falls dead immediately.

Attached to the imperial body guard is a corps of hunters, who, when on the chase in pursuit of edible game, provide themselves with envenomed missiles to be employed against wolves.

Latterly, poisoned arrows have fallen into comparative disuse as implements of war, owing to an increasing familiarity with fire-arms. We are acquainted with the contriver of a machine which was designed to be used against the English during the late war. It succeeded so well in picking off goats which were led over the cords communicating with it, that the military commission strongly recommended its adoption for destroying barbarian bipeds. Unfortunately for the patriotic inventor, the Treaty of Nanking caused the dispersion of the game just as it was ready, as he supposed, to be largely secured. It need hardly be added that in the hands of assassins, this easily obtainable poison would prove a potent means of destruction, as a slight puncture of an instrument charged with it, would from its rapid absorption be a sure *coup de grace.*

It is not our purpose to point out all the virulent agents which unscrupulous Chinamen are likely to employ against an enemy. We shall only add one more of the inoculating class, and that chiefly on account of its novelty. When the late commissioner Lin was devising means for the extirpation of English barbarians at Canton, some of the gentry of that city actually proposed to His Excellency to rid the place of certain prominent and obnoxious individuals by infecting them with *leprosy.*

Lin indignantly rejected the proposition as unbecoming a civilized people. That Chinese statesman was a brave and honorable man; his present Manchu successor has no claim to such virtues.

His chief objection to the use of leprous virus was, it is said, the tardiness of its action; it is believed that more than a month elapses after the introduction of the animal poison before it begins to show itself in its victim. Our knowledge of this foul malady is too imperfect to justify us in pronouncing such an inoculation as impracticable. Nor have we any remedy to propose for an officer who finds himself thus tainted.

There are poisons also which are *inhaled.* A person who aided a magistrate in the administration of a poison of this class gives the following narrative of the transaction, which was a *filiicide.* (Our apology for coining this word is, that it is needed to denote a crime, or rather extra-judicial practice not uncommon in China, resorted to for making away with dangerous adult sons.) The son of that officer was a lawless and incorrigible character, who by misdemeanors periled the safety of his family, and they determined on his removal. To effect that object without publicity no small finesse was requisite on the part of his father and friends. Suspecting their designs, he became excessively wary. On the day agreed for his execution, the father feigned to be withholding the son's much loved opium, until he could induce the hapless youth to take a draught of tea, which he was artfully led to suppose was drugged. At length, affecting to be wearied by the son's contumacy, the father gave him his opium pipe, mixing with the genial papaver another drug intensely poisonous. After a few inhalations the victim fell into a stupor, which was followed by convulsions to which his athletic frame succumbed in less than six hours.

To the same class belong those drugs which are employed by burglars for stupefying the inmates of the house to be robbed. Ever since we read in commissioner Lin's anti-opium diatribe, references to medicines used by robbers, kidnappers and sorcerers, which that statesman compared to the prohibited narcotic, we have been vainly endeavoring to investigate their nature. There is, however, abundant evidence that such agents are employed to induce stupor for criminal purposes.

Kidnapping male children for sale in Siam or the Straits has long been a common practice on the seaboard, and a short time since, to meet the demand for Chinese females in Cuba, many girls were kidnapped. The provincial capital—Hangchau, was thrown into consternation in consequence of the paucity of slave labor in the West Indies. Popular placards and official proclamations were posted everywhere, warning the inhabitants against the villainous agents of foreign barbarians who were prowling in search of female children. Two miscreants were detected with their little prizes and immediately beaten to death. From the documents published on that occasion it appears that for very young children a drug is employed which on being applied

to the face produces a degree of insensibility enabling the operator to lead the little one away unresistingly. For those of a larger growth, as well as for adults, something is given which by irritating the throat causes aphony. At other times they seem to employ an anæsthetic for criminal purposes.

We must adduce one instance of a proposal to stupefy by drugs of this character. When Ningpo was in possession of the English, a bold effort was made for its recapture by surprise. A large number of "braves" were secretly housed in the city, and a few hours before the time appointed for rising, the mandarin sent for distribution among a portion of the concealed force, a quantity of stupefying drug in the form of pastiles. Arrangements were made for a simultaneous attack on the west and south gates by night, and while some of those within the city were to set off noxious vapor in houses occupied by the English, others were to force open the gates. The plot failed through the dilatoriness of the fumigating squad. They arrived too late. The noise of the attack aroused the English, and its partial success, enabling a large force to enter the city, caused a dreadful carnage among the spirited assailants. Yet their confidence in the utility of fumigation was not impared, for it was not long after that a barbarian soldier was captured by this means and beheaded. Many were the plans set afoot for the capture of the English chief *Pu-ting ché*—for whose head ten thousand taels were offered.

It is said that for nearly every poison its antidote may be found. These soporific pastiles come within the number. The difficulty in poisoning cases is to know where to look for the desired neutralizer. That our toxicological notes may not be wholly devoid of practical information, we shall give some simple directions for the guidance of those whose premises are invaded by fumigators. It is assumed that you are wide awake at the time, for if you are caught napping there is no remedy. In the first place, then, take care that you do not open your mouth; but holding your breath, rush at the intruder and seize his cue in your left hand, while with the thumb and index finger of the right, you lay hold of his nose just above the alæ with a firm gripe; a bolus will drop out of each nostril, with which you are to plug your own nasal passage (be not fastidious) and you may then commence breathing (your mouth still closed)—for these medicated pledgets possess the property of decomposing the somnolent gas. If successful in these manipulations you will have the gratification of seeing your foe gasp and tumble over *hors de combat* into the pit he had prepared for you.

Allusions are often made to a mysterious and extremely virulent poison taken by men of high rank when on the eve of execution; it is derived, according to vulgar belief, from a protuber-

ance on the head of a species of stork. Whatever the agent may be, it is unquestionably one of great potency. An officer who was eye-witness to the decapitation of the venerable and lamented general, Yu Tsien, informs us that when that victim of Manchu malignity was lead out to slaughter, something was placed on the tip of his tongue, which, without the infliction of pain, rendered him insensible in less than half an hour. Friendly mandarins then retained his moribund frame in an erect posture to receive the painless death blow.

Nearly all the vegetable and mineral poisons known in the West are found in China, and have been employed for homicidal or suicidal purposes. Laurel water, hemlock, hyoscyamus, belladonna, stramonium, and nux vomica and a long list of other indigenous plants, known and unknown, are always at hand, though not often employed, owing to the facility of obtaining opium. Dogs are often poisoned by thieves by giving them rice in which nux vomica has been boiled. It is not an uncommon practice for countrymen to throw an infusion of *Croton tiglium* into a pond, a mode of fishing make easy—the morning following the operation every fish is found floating on the surface dead. They are then taken to market, but though somewhat insipid are innocuous. Some species of fish common on the coast are reputed to be intensely poisonous. Several kinds of mushrooms are also poisonous, and these, with other edible poisons are employed by those who aim at robbery or murder. For suicide, the most common agent, after opium, is the sediment of brine—which is highly corrosive. Pure gold is not uncommonly used; it probably acts in the same manner. Quicksilver has also been used for the same purpose; we are uninformed respecting its action. Arsenic, although cheap and abundant, is not easily procured, venders being held responsible for consequences, whether suicide or murder. The yellow sesquisulphuret (*orpiment*) abounds in Kungchàng in the S.W. of Kansuh. It is applied externally to poisoned wounds; as a sternutatory to counteract miasmatic effluvia in summer, and internally as a tonic in several diseases, and as a prophylactic; on the fifth day of each fifth month, persons of every age and condition drink spirituous liquor in which some powdered orpiment has been thrown, under the belief that it is a preventive of epidemic diseases. The Chinese do not consider this mineral as related in any way to arsenic. By arsenic they mean the red or protosulphuret, (*realgar*). This mineral is found abundantly in Sinyang-Honan. Arsenious acid (*white oxyd*) is also met with as a collateral product, it is said, in some glass works, derived doubtless from an ore of cobalt. The sulphurets were known to the ancient alchymists of China, and were early

employed in medicine; the utility of the last named in intermittent fever has not been long known, says the Pun Tsau (Materia Medica). Water in which common green beans has been boiled and pounded is given in cases of arsenic poisoning. It can be of use only as a demulcent. We are told that Mongolian hunters beyond the wall eat it to enable them to endure cold when patiently lying on the snow to entrap martens. In this part of China, arsenic is taken by divers, who in cold weather plunge into still water in pursuit of fish which are then found hybernating among stones at the piers of bridges.

We perceive with regret that the modern Chinese have added arsenic to their habitual stimulants. The red sulphuret in powder is mixed with tobacco, and their joint fumes are smoked in the ordinary manner. We have met with no habitual smokers of this compound of mineral and vegetable poisons, but persons who have made trial state that dizziness and sickness attend first attempts. After a few trials arseniated tobacco may be taken without any apparent inconvenience. From reports given of it we infer that its effects on the Chinese are analogous to what is observed among the arsenic-eating peasants of Austria. The use of arsenical vapor by inhalation merits the attention of physicians as a remedial agent.

At Peking, where arseniated tobacco is most in use, it costs no more than the unmixed article; it may be known by the red color imparted to the vegetable by the powdered protosulphuret. Its introduction is attributed to Cantonese from Chauchau. If this be correct, it is probable that these southerners, unable at the north to procure the masticatory to which they were addicted, sought to appease a craving for the pungent but harmless lime and betel-nut, by substituting the deleterious mineral gas. Many of the miserable victims of opium, to whom that narcotic is a necessity and not a pleasure, have eagerly employed the new stimulant to prop and exhilarate their exhausted bodies, and perhaps have thereby meliorated and prolonged their existence. We would fain hope that the use of arsenical stimulants will not become general; yet that pernicious custom is extending, and we know our race too well not to entertain fears on the subject. It is even stated that for a time at least, the reigning emperor in his boyhood preferred tobacco thus mineralized. Arsenical ores are used in the arts. In domestic economy the red sulphuret is employed for making away with rats and husbands.

There is no evidence that poisoning as an art has been practiced in China, and we search her annals in vain for a case parallel to that of Hongkong. Novelists sometimes describe the poisoning of armies or large numbers of people. The account of the aboriginal chief Manghwoh, who poisoned the springs of which the Chinese army drank, will recur to the reader of the historical

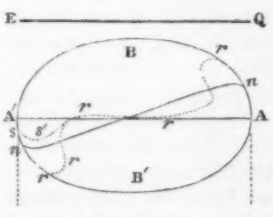
romance—the Three States. It may be that instances of this kind are founded on fact; but the obvious futility of any attempt to poison fatally on a large scale is a guarantee that it will be seldom resorted to in warfare. Could such appliances be made subservient to the destruction of masses of men, they would certainly be put in requisition, as total annihilation of antagonists is the aim of Chinese heroes: "no quarter" is their war cry.

Ningpo, March 2, 1857.

Art. XXVIII.—*Note on the Currents of the Oceans;* by James D. Dana.

[Communicated to the American Association at Baltimore.]

In the annexed figure, if AA' represent a large elliptical basin of water warmed on the side towards EQ and kept cold on the opposite, the isothermal diameter (or line of mean heat in the water's surface) will have the direction AA'. But if the water were put in equable circulation about the centre, in the direction of $ABA'B'$, the isothermal diameter, instead of having the direction AA' would run obliquely across, like nn', since the warm waters would be flowing in the direction BA', and the cold in that of $B'A$. Or conversely, if in such a basin, warm on one side and cool on the other, as stated, an isothermal line had this oblique position it would be evidence of an elliptical movement in the waters.



Again if the waters moved most rapidly towards the margin of the basin, then the isothermal line might take the form $ArrrrA'$. This form would also result from the gradual shallowing of the basin towards its sides, since a slight motion about the deeper parts would be magnified in the shallower waters of the border, (friction here being set aside, as it would have little effect if the basin were hundreds or thousands of miles in extent and of corresponding depth). Moreover, if either current, the warmer or colder, were an under current, the sloping sides of the basin would bear it up to the surface, and cause it there to affect the surface temperature, while elsewhere it might be unperceived. If in addition, the effect of the *colder* side were augmented, then a given isothermal line as $ArrrrA'$ might have a deeper bend on the side struck by the cold current than on the opposite, and so have the form $Arrrs'sA'$.

This figure and these conditions have a parallel in the oceans. The oceanic basins have their warm side against the equator, and

their cold towards the polar regions. In the isothermal (or isocrymal) chart in my Expl. Exp. Report on Crustacea, and also in this Journal, vol. xvi, p. 153, I have given the direction of the isothermal lines of the surface water of the ocean in winter—or rather, in the coldest month of the year, each line corresponding to the mean temperature of the coldest month. In this chart, the isothermal lines closely correspond with the above diagram.

The mean position of the line of 68° is about half way between the equator and the parallel of 55°, within which the circuit mainly lies; and we may, therefore, take this line for our illustrations. We may look first to the South and North Atlantic. In the *South Atlantic*, this line reaches obliquely across, from latitude 31° S. on the South American coast (the western side of the ocean, longitude 47° W.) to 7° S. on the African side (the eastern, in longitude 12° E.); and the line is almost straight, excepting the flexures near the coast, while the mean course makes an angle with the parallels or equator of about 22°. In the *North Atlantic*, the same line 68° F., is similarly oblique. It reaches from 56° N. on the American side, to 14° N. on the African, and the angle its mean direction makes with the equator is about 20°. Thus in each of these cases, the demonstration of the fact of an elliptical circuit movement in the ocean, is apparently complete. The modifications in the direction of the line are only those which result from the manner in which the South Atlantic and North Atlantic communicate with each other, it being such that the former contributes a large part of its warm waters to the latter, and so gives it a higher mean temperature.

The Pacific is a vastly wider ocean than the Atlantic, and the lines as they traverse the central waters, lose the most of their obliquity, since the movement is not much evident at the surface. But on the eastern border (the South American side) the cold waters are brought up to the surface by the Continent, as was long since explained by Humboldt. With this difference, the elliptical circuit is as apparent in the direction of the isothermal lines of the North and South Pacific as in the North and South Atlantic. In the *South Pacific*, the position of the isothermal of 68° F. off Australia is in latitude 30° S., and off South America in 2½° N.; and the mean obliquity through the ocean is 10 or 12 degrees. In the *North Pacific*, the line of 68° F. off Japan is in latitude 35° N., and off the North American coast in 21° N.; and the mean obliquity is about 10°. The elliptical circuit in the Pacific, each side of the equator, is therefore demonstrated by the temperature. The Indian ocean exhibits the same facts.

This demonstration for each ocean is independent of the exceptional surface current movements, which give varying and often perplexing results.

It should be observed further, that the temperature of the ocean's surface in the equatorial regions during the colder season

is little above 80° F., while that of the parallel of 50° is as low as 40° F., so that the former is 12° F. above 68° F., and the latter 28° F. below it. And hence unless the waters of the equatorial latitudes very much preponderated in quantity, the effect of the colder waters should be strikingly perceived along the east side of the ocean. In the North Pacific, as the ocean (as well as the globe) narrows north, the equatorial waters do thus strikingly preponderate. But little, if at all, is this the case with the South Pacific, since there is not the same convergence in the borders, and the ocean south of 30° is very free from islands, a fact indicating deeper waters. Besides, in the equatorial regions, the temperature diminishes rapidly in descending below the surface. There is abundant cause therefore for the excessive amount of influence of the cold waters on the western South American coast—an influence which is so great as to exclude a temperature of 68° from the Galapagos under the equator as well as from the tropical American coast very near to the equator.

In my former explanations of this chart, I recognized these circuit movements in accounting for the currents, as they had been laid down by Mr. Redfield. But in accounting for the remarkably low mean temperature of the South Atlantic, I manifestly attributed too much influence to polar waters flowing in from the far south. Now the waters which move eastward in all the oceans—those of the higher temperate latitudes—in this elliptical circuit, move faster than the earth by an amount equal to their apparent rate of motion; and they manifestly could not have derived this velocity from any source but their previous position in more equatorial latitudes where the earth moves faster. No other argument is needed to prove that the eastern movement is a counterpart of the western. In addition to this, since the waters flowing from the polar regions have less motion than the earth near the equator, and therefore are carried against the western side of the oceans, (eastern side of the continents,) as is well understood, (and was fully illustrated, upon the isothermal chart referred to, by the cold current down the Asiatic coast, as well as that better known along North America,) it is not possible that the South Atlantic current which flows towards the equator along western Africa can have accessions from the far south, as such waters would press against South America, the western side of the ocean; and there, in fact, as the chart shows, they do make themselves apparent. Its main supply is in the elliptical circuit itself as above explained.

My object here is not to discuss or dispute actual observations on currents, but to bring out a little more distinctly than has hitherto been done, the argument from the temperature of the ocean itself with regard to the grander points in the system of oceanic movements. The fact that the chart is a winter one for each ocean, does not affect the argument.

ART. XXIX.—*Contributions to the History of Ophiolites.* Part. II;* by T. STERRY HUNT.

IN the first part of this paper I have described various ophiolites from the altered Lower Silurian strata of the Green Mts., and I have now to notice the ophiolites of that ancient series of stratified rocks, underlying both the Silurian and Huronian formations, which we have designated as the Laurentian Series.

The crystalline limestones and dolomites of this ancient formation are occasionally associated with serpentine, which is sometimes disseminated in grains through them, or more rarely forms beds, in which the magnesian silicates greatly predominate. The dolomites of this series, unlike those of the Silurian rocks, contain very little oxyd of iron; and the same thing is true of the ophiolites. Hence the serpentines of the Laurentian series are paler in color, and have a less specific gravity, than those which we have already described. My examinations of them have not yet enabled me to detect the presence of either nickel or chrome, which characterize the magnesian rocks of so many other regions. The serpentines about to be described are more tender than those of the Green Mountains, and from their brittleness and pale colors, are less fitted for the purposes of decoration; they also contain a large amount of water, which may in part be hygroscopic.

The ophiolites of this series occasionally enclose small portions of mica and pyrites, and the calcareous ones sometimes contain sphene, and small crystals of phosphate of lime.

1. A calcareous ophiolite from Burgess, discovered by Dr. Wilson, is made up of a pale olive-green serpentine, somewhat crystalline in its texture, intermingled with a little magnesian carbonate of lime, which is sometimes white, and at other times reddish in color. The rock contains besides, some crystals of a greenish white mica, and disseminated pulverulent hematite, giving a red color to portions of the mass. When reduced to powder, it gave to boiling acetic acid, 6·28 p. c. of carbonate of lime, and 3·27 p. c. of carbonate of magnesia. The insoluble residue lost by ignition 14·5 per cent, and then gave to a boiling solution of nitrate of ammonia, an amount of magnesia equal to 0·67 per cent of carbonate, making a total of 3·94 per cent of carbonate of magnesia. The pulverized rock, ignited without previous digestion in acetic acid, and boiled for a long time with nitrate of ammonia, yielded 5·90 per cent of carbonate of lime and 3·84 of carbonate of magnesia, numbers agreeing with the

* See vol. xxv, p. 217.... This paper is extracted with additions, from the Report of the Geological Survey of Canada, for 1856.

preceding, while by the same process the unignited mineral gave 6·30 of carbonate of lime, and a large amount of magnesia.

The residue from the action of acetic acid, including however 0·67 per cent of carbonate of magnesia, gave by analysis:—

Silica,	42·10
Magnesia,	38·94
Protoxyd of iron,	3·69
Loss by ignition,	14·50
	99·23

2. A dull reddish brown ophiolite, from the same locality as the last, likewise contained a small amount of disseminated carbonates, which were completely removed by acetic acid. Thus purified, the matter gave on analysis:—

Silica,	39·80
Magnesia (by difference),	38·40
Protoxyd of iron,	7·92
Loss by ignition,	13·80
	100·00

The dark color and opacity of this rock seem to be due to the presence of disseminated peroxyd of iron, to which some foreign ophiolites appear also to owe their red colors.

3. A pale greenish gray ophiolite, nearly opaque, soft, and earthy in its aspect, occurs at the Calumet Island, on the Ottawa, and being sought after by the Indians, who fashion the stone into calumets or pipes, has given the name to the Island. It contains no lime, but after ignition, yields a trace of magnesia to a solution of nitrate of ammonia. Its analysis showed a mixture of an argillaceous matter; it gave:—

Silica,	37·50
Magnesia,	37·58
Alumina and oxyd of iron,	9·00
Loss by ignition,	15·00
	99·08

4. A white lamellar dolomite from Grenville, which held abundance of honey-yellow grains of serpentine, was examined. Small fragments of the rock were digested with cold dilute nitric acid, and the carbonates being slowly dissolved, the grains of serpentine were liberated, and were found to be only slightly attacked upon their surfaces, which were rendered dull and opaque. The larger grains, some of which were one-tenth of an inch in diameter, were selected for analysis, and gave as follows:

Silica,	44·10
Magnesia,	40·05
Oxyd of iron and alumina,	1·15
Loss by iguition,	14·70
	100·00

The serpentine makes up about one-fifth of the rock. The portion soluble in nitric acid, consisted of carbonate of lime 55·13, carbonate of magnesia 44·87, being a pure dolomite.

5. In this connection I will cite from my Report of 1850, three analyses of serpentines from the Laurentian rocks. I and II are specimens of the retinalite of Thomson, which occurs at Grenville, disseminated in a white crystalline limestone. This serpentine has a hardness of 3·5, and a density of 2·476—2·525; lustre resinous, shining; fracture conchoidal, without any traces of crystallization; translucent; color honey-yellow, passing into oil-green and olive-green. III is a serpentine closely resembling the last, from a similar rock at the Grand Calumet Island; it has a density of 2·362—2·381, and a pale wax-yellow color.

	I.	II.	III.
Silica,	39·34	40·10	41·20
Magnesia,	43·02	41·65	43·52
Peroxyd of iron,	1·80	1·90	·80
Soda,	(*traces*)	·80	——
Water,	15·09	15·00	15·40
	99·25	99·55	100·92

These serpentines, like the others from the same rocks already described, contain less oxyd of iron and a larger proportion of water than ordinary serpentine, approaching in composition to marmolite and deweylite.

Ophiolite of Syracuse, New York.—The rocks of the Onondaga salt-group in the Upper Silurian Series resemble closely those of more recent saliferous formations; they consist of red and green marls, marked by hopper-shaped cavities, and impregnated with sea-salt, and include great masses of gypsum, occasionally with sulphur, and beds of compact argillaceous dolomite, interstratified with others of a tufaceous cellular limestone. These strata are again overlaid by a limestone marked with peculiar needle-shaped cavities, which are ascribed by Mr. Vanuxem, to whom we owe this description, to a crystallization of sulphate of magnesia during the deposition of the rock.

At Syracuse, the strata between two beds of the porous limestones just described, are very much altered; the shales are rendered harder, and some portion of the calcareous rocks have become crystalline and are filled with crystals of celestine and calcite, while other beds are converted into a calcareous ophiolite, a specimen of which I have examined. It agrees closely with the description given by Vanuxem, being an aggregate of grains and rounded masses of serpentine of various sizes imbedded in a greenish gray calcareous base. The colors of the serpentine vary from blackish green to greenish white; it is often translucent, and takes a high polish. Small portions of bronze-colored diallage are disseminated in the ophiolite. Mr. Vanuxem

has also observed among these rocks, the existence of mica in aggregates having the characters of granite, and others in which hornblende replaces the mica, and which he compares to syenite.

He remarks of these metamorphic rocks of Syracuse, that we have here no evidence of igneous action or of the intervention of a dry heat, which he supposes however to be often concerned in alterations of this kind; and he suggests that water, aided by heat to produce the solution of the elements present, might give rise to the results there observed.—(*Report on the Geology of the 3rd District of New York*, pages 108–110.)

I found a portion of this ophiolite in powder, to be readily attacked by acetic acid, which dissolved a large amount of carbonate of lime, besides a little magnesia, and traces of alumina and iron. This proximate analysis gave: carbonate of lime 34·43, carbonate of magnesia 2·73, serpentine insoluble in acetic acid, 62·50, iron and alumina 0·34=100·00. The analysis of the serpentine gave me:—

Silica,	40·67
Magnesia,	32·61
Protoxyd of iron,	8·12
Alumina,	5·13
Water,	12.77
	99·30

No traces of nickel or chrome were detected. A rounded fragment of greenish fine-grained limestone, which was imbedded in this ophiolite, was found to be nearly pure carbonate of lime.

The presence of nickel and chrome, which is so constant in the ophiolites of the Green Mountains, is equally characteristic of the other magnesian strata of the same region. I have found there two metals in small quantities in nearly all the dolomites, magnesites, steatites, diallage and actinolite rocks of eastern Canada. I have also detected them in the serpentines of New Haven, Connecticut, and Hoboken, New Jersey, in a serpentine and a magnesite from California, in the serpentine of Cornwall, (England), and Portsoy, (Scotland), and in those of the Vosges, (France). The presence of chrome which characterizes so many ophiolites, had already been detected by Delesse in the latter locality. I have found it with nickel in a calcareous ophiolite from Corsica, and have also detected nickel in a serpentine from Mt. Rose, and in another from Basta, (Harz). Both nickel and chrome have besides been found by Hermann in the pyrosclerite of Pennsylvania, and by Brush in the antigorite of Piedmont, and the williamsite of Pennsylvania, both of them serpentine. The very frequent occurrence of nickel in the olivines and talcs of various localities has been noticed by Stromeyer and other

chemists. I may here remark that the chrysoprase of Newfane, Vermont, like that of Silesia, is colored by oxyd of nickel.

Vanadium is said by Ficinus to occur in the hydrophite of Taberg, and in the chromiferous serpentine of Zöblitz, while it was found by Schafhaütl in the bronzite of Genoa. The probability of finding vanadium in such associations is increased by the fact that this metal has been found with chromium in the limonites of several localities. It is however by mistake that I have indicated the presence of vanadium in the chromiferous smaragdite of Mt. Rose, and in a chromiferous serpentine from Gaspé, (this Journal, vol xxv, p. 437).

The chrome in the ophiolites of the Green Mts., exists in part in a condition readily soluble in heated sulphuric acid, but in part also as chromic iron, which remains with the separated silica, often associated with magnetite, and in the red serpentines with hematite. The nickel in these rocks appears also to be generally in the state of oxyd, but sometimes occurs in the form of a carbonate, as in emerald-nickel and pennite, and in a magnesite from Sutton, it is in the condition of nickeliferous pyrites.

Ilmenite, rutile and sphene are found in close association with the ophiolites of the Green Mts.; the first forms with magnetite a bed in the serpentine of Beauce, and sphene and rutile are met with in the accompanying chloritic slates, which are sometimes filled with magnetite and hematite, passing into a slaty iron-ore, which is frequently titaniferous. I have detected titanium in the unaltered red slates of this region at Granby, where they are associated with green sandstones and conglomerates, a carbonaceous shale, and an impure limestone remarkable for containing nickel and chrome with titanium. This limestone as described by Sir W. E. Logan in his report for 1847, p. 25, forms two beds of one and two feet in thickness; it weathers to some depth of a chocolate-brown color, from the presence of carbonates of manganese and iron, but has within a dull greenish gray color, and an earthy aspect. When moistened, the mass is seen to consist of a pale green base in which are imbedded darker green scales of chlorite, or perhaps glauconite, which appears to be the green coloring matter of certain Silurian sandstones. The rock in powder effervesces strongly with acetic acid, and a little hydrochloric acid having been added towards the close of the operation, there were dissolved, carbonate of lime 30·08, magnesia, calculated as carbonate, 3·68, oxyd of iron and alumina 5·45, oxyd of manganese ·058=39·76. The residue contained no lime, but portions of chrome and nickel, besides a large amount of titanic acid, amounting in two determinations to 5·3 and 6·2 per cent. The analysis was effected by fusion with carbonate of soda, and gave for 100 parts of the residue insoluble in acetic acid:—

Silica,	53·20
Alumina,	7·90
Protoxyd of iron,	15·75
Magnesia,	8·79
Titanic acid,	6·30
Oxyd of nickel,	·15
Oxyds of chrome, manganese, and loss,	2·45
Soda and potash,	·66
Loss on ignition,	4·80
	100·00

The ophiolites of Cornwall occur, according to De la Beche, among rocks of Devonian age. I have examined a clouded reddish brown and greenish serpentine, containing small grains of diallage, and said to be from the Lizard Point. It gave on analysis:—

Silica,	40·40
Magnesia, by difference,	37·43
Protoxyd of iron and chrome,	7·47
Oxyd of nickel,	·15
Alumina,	·65
Loss on ignition,	13·90
	100·00

I have examined specimens of the following serpentines without detecting the presence of nickel; in their general character all of them resemble the Laurentian serpentines.—

1. Pale greenish yellow granular serpentine, from Easton, Pennsylvania, density 2·501.

2. Fine wax-yellow translucent serpentine, from Montville, New Jersey; it contains veins of beautiful yellowish-white chrysolite, which has a density of 2·435.

3. Pale olive-green serpentine, from Phillipstown, New York; contains no trace of chrome.

4. Dark olive-green serpentine from Munroe iron-mine, New York; contains grains of magnetite but no chrome.

5. Pale green serpentine from Modum, Norway, with ilmenite and magnetite; contains no chrome.

6. Yellowish green serpentine from Newburyport, Massachusetts; density 2·551; this I have shown to be probably of Devonian age.*

Ophiolites have generally been regarded as intrusive rocks. In Southern Europe they occur in injected masses traversing the disrupted nummulitic strata, but they are also found in the same region interstratified with limestones, and with micaceous, chloritic and talcose schists which are regarded as altered triassic strata.† In North America the ophiolites of the Laurentian, Silurian and Devonian formations are all apparently magnesian sediments which have been metamorphosed *in situ*, and never so far

* Am. Jour. Sci., [2], vol. xviii, p. 198

† Coquand, Traité des Roches, p. 112.

as I am aware assume the form of intrusive rocks. The results of Sir W. E. Logan's examinations of the Green Mts. show that the Silurian ophiolites of Canada are the stratigraphical equivalents of a series of silicious dolomites and magnesites, whose alteration has doubtless given rise to the serpentines, talcs, diallages and chlorites. I have already shown that the action of a solution of alkaline carbonate at a slightly elevated temperature upon mixtures of earthy carbonates and quartz suffices to convert the bases of these into hydrous silicates. The same agent has at the same time given rise to the feldspar and mica of the associated strata.

We cannot doubt that rocks permeated by water, assume as Scrope and Scheerer suppose, a pasty condition at temperatures far below that required for their fusion, and if the mechanical conditions of great pressure and the disruption of overlying strata correspond to this semi-liquid state, the altered sediments, ophiolites and limestones, as well as amphibolites and granites, may assume the form of eruptive rocks.*

ART. XXX.—*On the Origin of the Sonorous Vibrations produced under certain conditions by Flames from Wicks or Wire-gauze;* by Prof. WILLIAM B. ROGERS.

IN the latter part of the article on Sonorous Flames, published in the July number of this Journal, it will be remarked that the explanation which is offered of the primary source of the vibrations has reference exclusively to inflamed jets of gas escaping from simple apertures and is not intended to apply to the sonorous vibrations observed in certain cases with flames arising from wicks or wire-gauze. I have indeed endeavored to show that these latter phenomena are directly dependent on the explosive character of the combustion, as in the case of the simple jet, but have not attempted to trace them to a mechanical source anterior to the explosive action. A few remarks on this part of the subject may therefore form a useful supplement to my previous communication.

The mass of gaseous matter which rises from a wick or from the meshes of wire-gauze is to be regarded as made up of innumerable streams variously intermingling and conflicting with one another. It cannot, therefore, be looked upon as the seat of an original and regular vibratory movement due to the discharge of the gas, like that which Masson and others have shown to belong to a simple jet. Nevertheless, it is evident that the flame and contiguous air must be impressed with some degree

* This Journal, vol. xxv, p. 36, and Journal of the Canadian Institute for May, 1858, p. 203.

of vibration anterior to the action of the explosions, as otherwise these would fail to have the periodic character which is necessary for the development of the musical effect.

The conditions under which the wick and gauze flames become sonorous point, as I think very clearly, to the source of these primary or determining vibrations. It will be observed that such flames, in order to become musical, must be placed near the entrance of the tube, and must be large enough to occupy a considerable part of the opening. In these circumstances the strong upward current created by the heat causes the air to enter the mouth of the tube, and traverse the narrow space between it and the flame with sufficient force to generate a feeble musical vibration of the aerial column, such as can at any time be produced by simply blowing from below against and into the mouth of the tube. This vibration although of itself too feeble to produce a decided sound, has the effect of periodically increasing and diminishing the intensity of the combustion, by conveying successively greater and less supplies of atmosphere to the flame. When the explosive stage has been reached, this agency continuing to operate renders the explosions alternately louder and feebler in rapid and uniform succession, and as the pulsations thus produced conform to the harmonic capacities of the tube, there arises a powerful continuous musical sound.

According to this view, the action of the flame in producing the sonorous effect in the case of wick and wire-gauze burners is twofold.

First: It establishes an upward current, and consequently an entering one which operating like a blast applied to the lower end of the tube generates a feeble vibratory movement of the included air.

Second: Its explosive combustion, rendered periodical by the action of the vibrating column, increases the intensity of the vibrations. These again, reacting, augment the difference between the intensions and remissions of the explosion, and thus by a cumulative process the vibrations rapidly attain the strength of a powerful musical sound.

Comparing this with the explanation given in my former paper of the cause of the musical vibration of simple jets, it will be seen that while in the latter case the primary source of the vibration is viewed as *inherent in the jet itself*, in the present instance it is referred to *the column of air in the tube*, but in either case it is the explosive action which strengthens the vibrations so as to produce the decided audible effect. It may be added that simple jet flames, when of large volume are to be considered as acting in part like flames of wick, creating an upward blast and thence a vibratory movement of the air column which combines with the primary vibration of the jet to produce the resulting sound.

ART. XXXI.—*Notes by Lieutenant E. B. Hunt, U. S. A., on a new Sounding Apparatus, proposed by him for Coast Survey use.*

THE device proposed has for its chief object to run sounding lines in harbors and water of moderate depth. The principle is that of measuring barometrically the pressure due to the depth, this pressure being transmitted to the barometric basin by a column of atmospheric air.

The method is as follows: Arrange a weighted india-rubber vessel for dragging on the bottom; connect this with a boat or surveying vessel by an air-tight tube of small bore; let this tube open into a cistern of mercury made air-tight; from this cistern arrange a vertical glass column, open at the top, in which the mercury can freely rise to any required height by the pressure due to depth.

The mode of use would be thus: Throw the weighted air-vessel overboard and let it sink to the bottom, it being connected with the vessel by the air-tube, in turn duly joined to the barometric cistern. Let the boat or vessel be propelled on a course. The air-vessel will be dragged along the bottom, and as the water must have free access to the bag enclosing the air, its pressure will compress the air to a density due to the depth. This pressure will be communicated along the tube to the vessel or boat, and being received on the mercurial surface will raise a column to such a height that its weight will equal the weight of an equal column of the water, whose height is the depth to which the air-vessel is sunk, or rather that of the lowest part on which the pressure acts. As this depth varies the height of the column will also vary. The relation of these heights is expressed by the specific gravity of mercury divided by the specific gravity of the particular sea or other water in which the soundings are being made. It would be necessary to make occasional observations with the hydrometer, and in the case of tidal streams these should be quite frequent.

The following is my general idea of the construction of the parts.

The air-vessel should be an easily flexible india-rubber bag, of a pear shape, with a tight neck screw on which to fasten the pipe. Around this bag, a pear shaped metal case must be adjusted, of weight sufficient to sink the air-vessel and connecting tube rapidly. I suppose lead will be the best. The form is important; it should be such as to offer but slight resistance in being drawn through the water. It would be best to throw a large preponderance of the weight on one side of the swelled part, so as to make that side keep towards the ground. The superior forward surface can then be so arranged as to bring into action,

if needed, a component acting downwards and due to the forward dragging. The india-rubber bag should then be fastened to the lower part, so as to compel it always to indicate the pressure corresponding to the same distance from the ground.

The tube should, I suppose, be made of the common patent gas-pipe, (of india-rubber and canvas,) the smallest bore being preferable. This tube must be laid either with wire or fishing-line of such strength as safely to bear the strain. By first laying lengthwise all around the tube a series of wires or twines, and then wrapping them all firmly, the strain of dragging would come almost wholly on the wires or twines, and yet the whole will be quite flexible. If a smaller size of flexible tube which will sufficiently resist inside pressures can be got, it will be better, for as the pressure within will always exceed that from without, the arching stiffness is not required. As the wrapping will greatly reinforce the tube, a moderate strength of the inner tube will suffice. In service, I suppose the tube should be arranged at a number of points for fastening to the boat's or vessel's stern, so that the length out shall be always easily seen. I presume it might very well be dragged at a slope of about $\frac{1}{4}$. All the tube not paid out is to be coiled between the stern and the gauge. By loading the air-vessel the slope at which the tube can be dragged may be increased, or as before indicated, by a head armature or blade, giving a downward component. As the effect of the change of tube slope will be but slight on the horizontal distance between the boat and the air vessel, the sounding at any instant may be taken to belong to a constant distance astern for each of the knots or loops of the tube. Thus a boat or vessel will give a continuous indication of depth along the line over which it passes. It will at once be seen how great an advantage this will give in dragging for bars or shoals along channel ways.

The air-tube is to open into a cistern or basin or syphon branch, connecting with the open-glass indicator or scale tube, the whole to be gimbal mounted, and the tube to be led along the gimbal axes. The graduation can be made differential, so as always to show the inches of pressure. It would probably be on the whole quite as advantageous to have merely a glass tube of about one foot long, fastened on an india-rubber tube, and arranged to slide up and down on a scale, the flexible tube connecting with the fixed cistern. If great depths are attempted with this combination, this will be necessary.

There would be some advantages in using an incompressible fluid in place of air, whose small specific gravity would give a differential pressure. Thus sulphuric ether has sp. grav. = ·715, absolute alcohol do. = ·792, olive oil do. = ·915, whale oil do. = ·923, either of which introduced into the tube and bag, and resting on the mercury would give a tolerable indication,

or if used as the reading fluid without mercury would be perhaps too sensitive. Sea water being of the sp. grav.= 1·026, we see that sulphuric ether will give over three feet on the scale for 10 feet in depth, and whale oil just about one to ten. Linseed oil, sp. grav. = ·940, would be more manageable, and turpentine, sp. grav. = ·991, would, if its fluidity sufficed, be very good. Wine is = ·992, and if it could be kept pure might do, though too little sensitive in fresh water. If we assume that 100 feet is our limit of depth to be sounded, we can readily proceed from this to fix the size of air-vessel required if air is used, or the length of scale in case any of the fluids named are used alone or with a mercurial reading column. There is the objection to these fluids that the height of the cistern level above the sea must be considered, but if air is used this may be neglected. A careful study of their possible combinations will probably indicate substantial reasons for a preference. If air be used, the air-vessel must be so large that it will be supplied with air at the maximum depth anticipated, for which purpose the entire air space of the tube and cistern must bear a less ratio to that of the air-vessel, than the pressure of one atmosphere to the pressure due to the maximum depth in the densest water. The air space being fixed, the weight must suffice to sink this readily, but as it goes down the sinking power will increase, thus partly counteracting the lifting effect of dragging on the sloping tube. If we assume 100 feet as the maximum and $\frac{1}{4}$ the slope, this tube must somewhat exceed 400 feet, and the part out will be varied as the depth, though the whole will be in action as a connection at all times.

These indications may suffice for the simple barometic form. There is, however, a far finer possibility which may be ultimately attained. That is the making this arrangement self-registering. Suppose a sheet of paper made to traverse over a roller, either by watch work or by a mechanism moved by a screw-propeller fixed to the side of the surveying vessel or boat. Then suppose a pencil point connected with a float on the top of the mercurial column, and made to traverse the recording roller as it rises or falls. This would trace a curve of record truly proportional to the bottom dragged. But this arrangement would be difficult and intricate. Suppose, however, that a light fluid is used in the chamber of the drag, the tube and the cistern, and let this cistern be made of shurred or corrugated material, of a long cylindrical form, one head of the cylinder being fixed and the other acting against a spring. If now this moving cylinder-head bear a pencil point traversing the recording roller, it will indicate depths by ordinates which can be read by a fixed scale. I suppose that spring clock work moving a record sheet might be combined with this corrugated cylinder so as to give a record proportional to time without very great difficulty. But the moving of

the sheet by a side propeller, so that the abscissas would be proportionate to the spaces traversed, is very much the most desirable form, and possibly may not present too formidable difficulties. It would doubtless be best to experiment first with the barometric form; and if no unforseen obstacles occur, the greater object can then be maturely considered, and if practicable, fully realized, to the vast advantage of hydrography.

ART. XXXII.—*Lanthanite and Allanite in Essex county, N. Y.;* by WM. P. BLAKE.

IN this Journal, vol. xvi, Sept., 1853, I announced the occurrence of carbonate of lanthanum at Bethlehem, Pa., associated with ores of zinc. At that place a mass of closely aggregated thin tabular crystals was taken out from an ochery soil overlying a bed of calamine; but though diligent search has since been made at the same place, and at other points in the vicinity, not a single additional fragment has been found, and this interesting species has continued to be almost as rare to mineralogists as when first described.

I have since found the mineral in the town of Moriah, Essex county, N. Y., at one of the openings on the great bed of magnetic iron ore, known as the "Sanford ore-bed." It occurs in a thin crust or layer of small crystals and scales on the walls of fissures in the ore, and, occasionally, upon crystals of allanite.

When examined under a magnifier, the lanthanite is seen to be in thin crystalline plates, and in prismatic masses with a cleavage like that of mica or selenite. On some of the specimens the crystals are brilliant, and contrast finely with the black ore upon which they are spread. Their lustre is pearly, and in color they vary in different specimens from white to a delicate pink or rose tint, thus indicating the presence of didymium.

The magnetite at this locality is associated with phosphate of lime (apatite) in small reddish-brown crystals, known in that region as *red sand*. In portions of the bed it is the preponderating mineral, and is disseminated in belts or layers parallel with the walls.

Allanite occurs abundantly along the plane of contact of the bed of ore with a mass of granitic rock which appears to be different from the true walls of the bed, and may be an intrusion or segregation in its midst. The removal of the ore left a large surface of this granitic wall bare, and allanite crystals were found implanted upon it, in a dark red feldspar and in the iron ore. The crystals are unusually large and perfect, several of them, (of which, however, only fragments were obtained,) could

not have been less than eight or ten inches in length, six or eight broad, and from one to two inches thick. The surfaces of even the largest crystals are very smooth and perfect, and the fracture is conchoidal and highly lustrous. This is without doubt the best locality for obtaining cabinet specimens of allanite yet known in the United States.

The lanthanite at these localities is probably formed by the slow decomposition of allanite. The thin scales and the layers of crystals in the fissures of the iron ore and on the surface of allanite are, to all appearance, the result of the action of percolating surface-water. The beautiful mass of lanthanite in the soil at Bethlehem may have resulted from the decomposition of an isolated crystal or boulder of allanite, which mineral has been found to be abundant in that region.

ART. XXXIII.—*On the Formation of Rotating Rings by Air and Liquids under certain conditions of discharge;* by Prof. WILLIAM B. ROGERS.

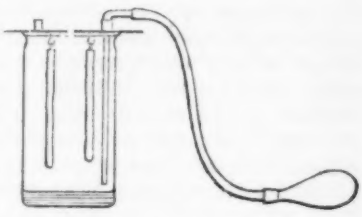
IT has long been a familiar fact that the bubbles of phosphuretted hydrogen gas consisting of PH_3 with an admixture of PH_2, give rise by their explosive combustion in the air to a ring of white vapor-like phosphoric acid, which dilating as it ascends exhibits a rotation of each vertical element around the curved axis of the figure. A similar motion is sometimes discernible in the smoke from a cannon, and in the steam which escapes by momentary puffs from a steam-pipe, and as expert smokers know, such revolving rings are readily produced by ejecting the smoky breath in a peculiar manner from the rounded opening of the lips.

In studying recently the phenomena of air-jets, I have been led to a somewhat critical examination of the conditions under which these ring-discharges are produced. By the use of suitable arrangements I have been able not only to trace the development of the rings produced in air projected from apertures, but to detect similar movements in that which is released by the bursting of an ordinary bubble. I have, moreover, by a modified contrivance succeeded in forming at will similarly constituted rings from water and other liquids, and in tracing them to the same mechanical causes which give origin to the rings of air. As the methods of experimenting which I have adopted, as well as most of the observations, appear to be new, and as the mechanism of these beautiful effects has not, that I am aware, been specially treated of before, I trust that the following details may be regarded as a not uninteresting addition to our knowledge in this department of inquiry.

I. *Of the air-rings formed by momentary discharges from an aperture.*

1. *Mode of producing the air-rings.*—To render the form and internal movements of the escaping air in such cases distinctly visible, I use a large glass reservoir, (fig. 1,) in which the air is kept opaque by a continual supply of chlorid of ammonium generated within. To the top of the jar is adapted, by grinding and an unctuous cement, a zinc or glass cover pierced with three holes, viz.: a central round aperture one inch in diameter, and two others of much smaller size, each furnished with a short socket-tube rising above the plate. Of these, one is intended for connection with tubes of discharge, and is kept closed when the central orifice is in use. The other receives a slender glass tube, entering above by a rectangular bend and descending to within two inches of the bottom of the jar. At its outer end this is connected with a flexible pipe through which the operator, impelling the air in successive puffs into the lower part of the vessel, can at will eject corresponding volumes of the cloudy air through either of the apertures. For this purpose he may either use the mouth, or a gum-elastic bag attached to the end of the tube—the former being in most cases the preferable instrument. At equal distances on opposite sides of the central hole, two hooks are affixed to the lower surface of the plate, from which are suspended long slips of thick cotton cloth.

1.



To prepare the apparatus for experiment, we remove the cover and pour into the jar common hydrochloric acid to the depth of half an inch, adding to it one or two cubic inches of nitric acid. The slips of cotton cloth, after being dipped in strong water of ammonia, are replaced on the hooks, and the cover restored to its position with a slight pressure to render the junction firm and air-tight.

The included air quickly becomes opaque with the dense cloud of chlorid, and by applying the lips to the free end of the flexible tube may be expelled from the aperture which is left unclosed, either in the form of successive puffs or of a continuous jet. It is almost needless to say that in making the experiment the surrounding air should be as little moved as possible, the slightest agitation near the aperture sufficing to mar the symmetry of the effect.

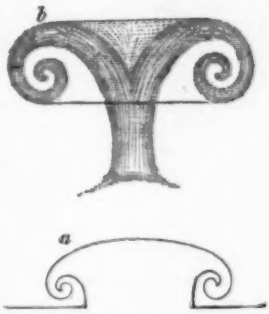
2. *Stages of the ring-formation.*—When by a moderately strong impulse the cloudy air of the jar is made to issue in a succession

of quick but not violent puffs, each little cloud assumes near the aperture the form of a ring, which gradually dilating as it rises retains its symmetry until it has reached the height of two or sometimes even of three feet above the opening.

Using a gentler and less sudden impulse we cause the ring as it ascends to carry with it a train of cloudy air *which forms the downward continuation of the inner portion of the coil.*

With a still lighter breathing at the mouth-piece we may expel the air in so gentle a wave as to be able to mark the escaping cloud rolling slowly over on each side of the aperture without breaking its connection with the central mass—the whole thus assuming the appearance of the top of a column adorned with volutes. In this experiment no actual ring is generated, but we have the opportunity of watching the beginning of such a form and tracing the mechanical movements to which it owes its development. In fig. 2 the earliest stage is indicated by *a*, and the imperfectly formed ring with part of the attached train by *b*, the lateral sections of the ring only being represented.

2.



When the discharge is produced by a stronger impulse than in the case first mentioned, the resulting ring darts upward so rapidly as to break away from its train, leaving the latter either to lag behind as a formless mass, or, when retaining sufficient velocity, to evolve from its own substance a second and smaller ring which is seen quickly pursuing the first. By applying a yet more energetic force, we may cause the ejected air to form three, four, or even a greater number of such successively developed rings.

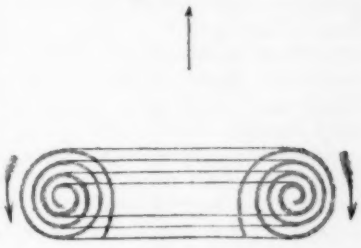
The size of the ring when first formed is dependent chiefly on the width of the aperture, and in some degree also on the strength of the blast. With a hole one and a half inch in diameter, and a proportionally large injecting tube, it is easy, by a suitable impulse of the breath, to generate rings of from two to three inches in diameter of the most perfect symmetry, and having force enough to ascend unbroken to a height of six or eight feet. In this way we may render these beautiful phenomena visible over a large apartment, causing the smoky wreaths to chase each other until flattened against the ceiling.

If instead of the mouth we use the elastic bag as a means of impelling the cloudy air, we find that a quick pressure and subsequent withdrawal of the hand give rise to rings of great symmetry, and that these are usually unaccompanied by any train.

The latter result is evidently due to the sudden recoil of the bag, and the consequent retraction of the latter part of the cloudy mass back into the reservoir. By continuing the pressure so as to prevent the recoil we may produce the same phases of the phenomena as when the impulse is given by the breath.

3. *Rotation and structure of the air-rings.*—To obtain a distinct view of the motion and internal structure of the ring, it should be viewed in a nearly horizontal direction, and by a strong transmitted light. This is conveniently done by placing the apparatus on a table a little below the level of a gas lamp, but at a considerable distance from it. It will then be seen that the rotation of the ring, either in its incipient stage, or with the attached train, or when entire and separate, has always one direction, the inner circumference being carried forwards or in the ordinary mode of experiment upwards, and the outer in the reverse direction, as shown in fig. 3. In order that the eye may readily follow this motion in the interior of the ring while it retains its perfect form and rapid rotation, the air of the reservoir should be only moderately cloudy, and the impelling force quick without being violent.

3.



Under these circumstances we observe *the ring to be made up of a coil of cloudy air—between the folds of which is rolled up a similar coil of transparent atmosphere.*

When the ring carries a train it is easy to discern that the cloudy spiral is continuous with this attendant mass, and really issues from it near the inner circumference of the ring. In a yet earlier stage of the action we are able to mark the beginning of this two-fold spiral by observing how each volute as it draws its supply from the central mass gathers in a portion of the clear external air to be enfolded between its turns.

4. *Origin of the rotation.*—This is obviously referrible to the combined agency of the outward impulse and the resistance which the sides of the issuing mass encounter from the edge of the opening, and from the air into which it is impelled. The former of these forces, due to the tension propagated through the reservoir, must to some extent operate in diverging directions, while the resistance acts in nearly opposite lines. Thus, at the outset, there would be produced a reversion or curling of the issuing cloud around the aperture, which, as the action continued, would be developed into the spreading volutes before described, and at length into the perfect and rapidly revolving ring.

The dilatation of the ring in its ascent would seem to be the natural result of the divergent character of the impulse impressed upon the air as it passes from the orifice.

5. *Horizontal bands of the ring.*—On examining a ring in which the clear and cloudy spirals are plainly distinguished, it will be found to have the appearance of *alternating layers or bands of cloudy and comparatively clear air arranged horizontally*, but which are most strongly marked towards the top and bottom of the ring, and cease to be discerned near the middle. When the air employed is only moderately cloudy, and the rings are large and perfectly developed, this banded appearance is admirably brought out by a mild transmitted light, and adds not a little to the beauty of the revolving and expanding wreath.

It is easy to see that this apparent structure is an *optical illusion* due to the passage of the light alternately through a greater and a less thickness of the cloudy lamina of the composite ring. Thus it will be observed (fig. 3) that the rays coming to the eye in the horizontal plane which passes through the upper part of the cloudy spiral will be much more obscured than those which pass in a parallel plane through the clear space immediately beneath, the former having to pass lengthwise through a considerable distance in the cloudy layer, while the latter traverse little more than twice its thickness. The same relations must hold for the next inner turns of the spiral, but as its circuit grows narrower the difference between the aggregate of clear and cloudy portions passed through must continually grow less, and near the equator of the ring become quite insensible; hence the bands which are so distinctly marked towards the top and bottom of the ring disappear as we approach its midway line.

6. *On the effects produced by a continuous blast.*—By slightly *prolonging* the impulse either from the mouth or the bag so as to expel a comparatively large amount of the cloudy material at a moderate velocity we are able to mark the partial formation of a second ring in the swollen part of the train which still adheres to the first, and even of a third yet more imperfect one in the train prolonged below the second, the whole still forming a united mass.

With a *continuous and uniform blast* of moderate force the appearances are even more curious and instructive. The column in this case retaining its smooth cylindrical outline for only a short distance above the aperture, presents higher up along its sides, and at nearly equal intervals, a succession of whorls or volutes, more and more developed as we ascend, and which not unfrequently terminate at the top in a nearly perfect and separate ring, (fig. 4,). On urging the blast with a much increased velocity these lateral markings of the column become less conspicuous, and assume throughout, nearly to the summit, the aspect of a

series of short projections curving steeply downwards, like the lowest and least developed volutes in the preceeding experiment.

On examining these lateral gyrations as shown in the figure it will be seen that each is formed at the expense of the adjacent parts of the column both above and below it. The central arrows pointing divergingly upward indicate the direction in which the inner portions of the stream are deflected to unite with the wider part of the spiral; the exterior arrows directed downwards mark the relatively retreating motion impressed by the resistance acting at the sides, and show the course of the particles passing into the spiral from above.

4.

It would seem that these movements must have the effect, superficially at least, of dividing the column into alternate tracts of rarified and condensed air, the former situated about midway between the successive coils, and the latter directly above where the coils unite with the main mass. These regular alternations, virtually equivalent to a system of waves or vibrations generated in the effluent stream, indicate the analogy in condition of large streams of gaseous matter, and the slender jets in which such vibratory movement has already been demonstrated, and point to one of the agencies which may be concerned in the latter phenomena. They at least furnish conclusive proof that *even a large stream of gas discharged under a steady pressure does not flow with continuous uniformity, but becomes the seat of periodical movements at equally recurring intervals.*

II. *Of the motions of the air produced by the rupture and by the explosion of bubbles.*

As the beautiful rings developed by the explosive combustion of phosphuretted hydrogen gas are formed under the influence of far more energetic forces than are brought into play by the rup-

ture of a bubble of common air, it becomes important to determine what kind and amount of effect is due to the simple bursting of the bubble independent of any explosive action. I have, therefore, made numerous experiments on bubbles of common air rendered cloudy as in the previous experiments, and have been much interested by discovering that in all such cases *a distinct rotary motion is produced corresponding with that of the air rings already described.*

7. *Mode of experimenting with floating bubbles of air.*—In order to observe the movement of the air occasioned by the bursting of the bubble I use a deep glass bowl, into which is poured a layer of water containing soap enough to give durability to the bubbles when formed on its surface. A finger bowl of the largest size answers for this purpose. Placing this on the table near the ring apparatus (fig. 1) previously charged with very opaque air, I attach to the tubulated aperture of the jar a flexible pipe terminating in a glass tube of about one-tenth inch in diameter. Dipping the end of the tube into the soapy water so that it may take up a short column of the liquid, I hold it centrally over the water and close to the surface. Then breathing carefully into the mouthpiece, provided for this purpose with a narrow opening, I form a floating bubble of any size from a half inch to three inches in diameter. This being done the glass beak is to be gently lifted away, and the bowl covered with a glass plate, brought over it with a sliding motion. The bubble must now be left undisturbed for fifteen or twenty seconds, to allow its contents and the air of the bowl to come to rest, at which time the suspended cloud will be seen to have subsided a little from the apex, showing a level surface above.

As it is necessary for a satisfactory observation that the rupture of the bubble should begin exactly at the top and extend symmetrically around that point, and as in the spontaneous bursting this only occasionally occurs, it is expedient not to wait for the rupture but to force it by means of a wire inserted vertically through the apex and quickly withdrawn, the glass cover having first been removed by a gentle sliding motion. When this has been done so as to avoid agitation we see a cloudy column rising some inches above the liquid, and rolling over in delicate volutes at the top.

With a bubble of from one to one and a half inches in diameter the symmetry of the resulting column is quite striking and *its correspondence in motion and shape with that already described as an early stage of the ring formation is not to be mistaken.* In many cases a perfect and almost separate ring is developed at the top, and when the air is not too opaque the alternate coils and the resulting horizontal bands are perfectly distinct. But

from the feebleness of the rotation these appearances are only momentary. When the bubble is two or three inches in diameter, the outward and downward curling at the top of the cloudy mass is still quite observable, although much less marked than in the preceding case. When very small bubbles are broken, the motion is too quick and the cloud too small for satisfactory observation.

(8.) *Origin of the rotation.*—It thus appears that in the mechanical rupture of a floating bubble forces are brought into play similar in kind and general direction to those operating on the ring-discharges from an orifice. Of these, one is evidently the *tensional action of the liquid film* driving the cloudy air through the opening, another is the *resistance of the adjoining air* into which the mass is impelled. The former corresponds in effect to the tension propagated through the reservoir in the previous experiments, the latter is the same in both cases; and we may consider the widening aperture of the bubble through which the air is thus as it were squeezed, as answering to the orifice on the top of the jar.

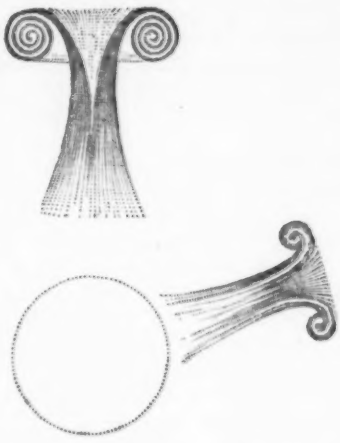
This view of the mode of action of the film is confirmed by the very curious effect which results when the bubble is punctured on one side. Thus applying the point of the wire near the base we see the cloudy column rushing out in a nearly horizontal direction on that side. If we pierce the bubble at an intermediate height the air is projected obliquely upward towards the hand. It can hardly be doubted therefore that in all such cases *the bubble is destroyed by a progressive and regular enlargement of the opening first made, and that this takes place with sufficient slowness to allow the aperture to give direction to the extending force.*

(9.) *Rings generated from spherical bubbles.*—The effects just described are produced in a still more striking degree by the rupture of bubbles of completely spherical form. In this as in the former experiments the utmost care must be taken to protect the adjacent air from agitation. With this view the bubble as soon as blown should be deposited at the bottom of the glass bowl, on a piece of soft cloth or a flake of carded cotton, and left undisturbed for ten or fifteen seconds. On piercing it at the top with a very slender wire *we see its contents suddenly projected upwards some inches*, forming a cloudy column whose summit rolling over on all sides develops *a beautifully distinct ring* which at times ascends so rapidly as to separate from the general train.

The effect is best seen with a bubble of from three-fourths to one inch in diameter. When the contiguous air is perfectly quiescent the ring retains its form even above the top of the bowl, affording a clear though momentary view of its twofold spiral and the resulting horizontal bands, as well as of the direction of its rotation. When pierced at the side instead of the

apex, the bubble, as might be expected, projects its contents towards that side in the direction of the wire, showing though less perfectly the same configuration. Both effects are rudely indicated in fig. 5.

5.



As these experiments on the rupture of bubbles will be found to have much interest, I may suggest that they can be easily repeated by forming the bubbles with tobacco-smoke blown from the stem of a common pipe, from which they are readily transferred to the soapy water as spherical segments or to the cloth surface as entire spheres. But it must be remembered that even a slight motion of the contiguous air will defeat the observation.

I need scarcely add that the tensional action of curved films of liquid, so strikingly shown in these phenomena, has been illustrated by Prof. Joseph Henry in a series of interesting experiments of which an account was published some years ago.

In the present case the most important inference to be drawn from the results is that the destruction of the bubbles proceeds not from a subversion of cohesion irregularly throughout the film, but from a uniformly progressive enlargement of the opening first formed, by the continuous retraction of its edge.

(10.) *Of the rings produced by floating bubbles of phosphuretted hydrogen gas, when exploded.*—In what has just been stated we mark the effects simply of the mechanical rupture of the bubble, calling into play as a motive agent the tensile force of the film, or what is equivalent, the expansive action of its contents released from the pressure under which they have been held. But in the present case the rupture has no sooner begun than a chemical action of great intensity sets in between the included gas and the air. This commencing usually at the apex and extending downwards and laterally *in a symmetrical manner* gives rise to a powerful expansive force having an obliquely upward direction on all sides. The products of the combustion are thus impelled into the contiguous and comparatively quiescent air under conditions very analogous to those of an energetic momentary discharge from the ring apparatus of the former experiments. The resistance at the sides of the ascending and spread-

ing column, combining with the upward impulsion of the interior will, therefore, give rise to *a similar rotation of the cloudy mass*, rolling it up into the spirally constructed ring in which it presents itself at the close of the explosive action.

It will be remarked that these explosive rings are more rapid in their expansion as well as their rotation than the rings produced by mechanical discharge, a result due doubtless to the greater energy of the forces by which they are developed. As might be expected, rings of the latter kind approach more nearly to the former in these particulars when a vigorous impulse is applied in producing them.

In most cases the wreath of phosphoric acid is so opaque as to preclude the examination of its interior structure, but when more diluted, we are able to trace within it, as in the other rings, the two-fold coil of cloudy and clear atmosphere.

In experimenting with the explosive bubbles every one must have noticed the frequent occurrence of irregularities and failures in the production of the ring. This is a natural consequence of the rupture beginning on the side or at more than one spot, instead of commencing at the apex of the film, and accordingly in such cases it will be remarked that the flame and smoke dart out laterally, producing a broken and almost formless wreath.

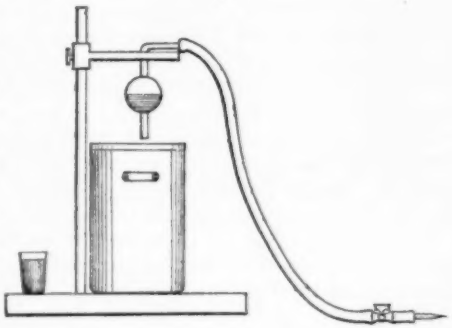
III. *Of the formation of liquid rings.*

The production of liquid rings by a succession of drops, although only of occasional occurrence, has doubtless often been observed in the course of laboratory manipulations. Yet so far as I am aware no attempt has hitherto been made to determine the structure and movement of these rings, or the precise conditions under which they are generated. My attention having been called to this class of effects by some remarks of Prof. Horsford on the rings formed by precipitated sulphate of lead, I was led after various trials with this and other precipitates to discard the chemical action as irrelevant to the particular effect in view, and to employ as a dropping-liquid water charged with some coloring substance, either suspended or dissolved. Among the materials thus used may be mentioned chromate of lead, carbonate of lead, sulphate of lead, sulphate of baryta, cobalt blue and dilute solution of sulphate of indigo. Of these, the two first and the last yield perhaps the most perfect results.

11. *Production of liquid rings by drops.*—A convenient apparatus for these experiments consists of a globular pipette (fig. 6, see next page) of about two inches in diameter, mounted on an arm which is capable of turning easily in a horizontal plane, and a large cylindrical vessel filled with clear water nearly to the brim. The beak of the pipette, about an inch in length, has a smoothly

ground aperture of one-tenth inch. The upper tube, bent at right angles, is fastened into a flexible pipe about eighteen inches long, to the outer end of which is adapted, by means of a small stopcock and short gum-elastic tube, a slender tube of glass drawn to a fine capillary bore.

6.



In order to charge the pipette, we revolve the horizontal arm into a convenient position, and bring the small vessel containing the colored liquid up to the beak. Then slipping off the coupling tube we apply the lips at the stopcock, pump up the charge and quickly closing the stopcock replace the coupling and capillary tube. After one or two drops have fallen the flow ceases and the pipette may be brought round over the centre of the reservoir. By opening the stopcock either partially or wholly we have perfect control over the rate of discharge, and can make the drops succeed each other as slowly as we please.

It should be observed that air bubbles carried by the drop into the liquid produce an irregular motion, destructive of the desired effect. Hence the beak should be placed only a short distance above the surface. An interval not exceeding one and a half inches usually answers very well, but at a distance of from one half to one inch admirably uniform results are obtained. Indeed, it is not necessary to the effect that the drop should reach the surface with any sensible velocity, as a well-formed ring will be produced by simply *laying the drop upon the water* from the closely approached beak of the pipette.

As it is essential to a perfect experiment to have the liquid of the reservoir as motionless as possible, its mass should be large, and it should be allowed to come to rest after each drop before the next is allowed to impinge upon it.

Operating with these precautions, and viewing the result from a point a little lower than the level of the fluid, we see that the drop, soon after merging in the liquid, gives origin to a ring of exquisite symmetry, which rotates and enlarges as it descends, precisely after the manner of the gas-rings already described. In some cases the ring, continuing unbroken through the whole depth, spreads out on the bottom a flat annulus of the heavy

coloring matter. But usually, after reaching a distance of four or five inches, it breaks up with a peculiar outward uncoiling motion, forming at intervals of the circuit flattened spaces, from the outer points of which the pigment is seen dropping in numerous slender streams.

12. *Motions and structure of the liquid rings.*—The rotation of the liquid ring on its circular axis is directed upwards on the outer circumference and downwards on the inner; or viewed in relation to the progression of the mass, it presents an advancing movement of the inner and a retreating movement of the exterior periphery. It is thus identical with the rotation of a gas-ring impelled in a descending direction.

The liquid ring, moreover, resembles that of gas in being composed of a coil of colored fluid enfolding a parallel uncolored coil. Indeed, when sufficiently translucent, it exhibits quite distinctly the horizontal bands which, in the case of rings of cloudy air, have been shown above to be an optical result of this twofold structure. The correspondence between the phenomena is rendered still more complete by the fact, that the liquid ring is followed by a residuary colored mass, which, when the forming impulse is feeble, remains attached to it as a train.

13. *Formation of liquid rings by impulsive discharge.*—The observed identity of motions and structure in the two classes of rings led me to attempt the production of liquid rings by a mechanical process similar to that used in forming the rings of air. For this purpose I lowered the beak of the pipette so as to immerse it a little below the surface of liquid in the reservoir, and closing the stopcock applied a sudden and transient pressure of the fingers to the flexible tube. The experiment was eminently successful. The colored liquid thus discharged was seen to shoot downwards in the form of a very perfect ring, in all respects resembling those above described, except that its rotation and expansion were more rapid. Modifying the arrangement, by attaching to the stop-cock a small but thick gum-elastic bag, I have found it easy to regulate the impulse so as to develop the rings as slowly as may be desired, and thus to reproduce with the colored liquid all the stages of the phenomena previously marked in the case of rings of air. In this way, by a gentle and rather gradual force, I can cause the escaping fluid to roll up into lateral volutes, or, increasing the action, to form the opening ring with its attached train; or, by a yet quicker and stronger impulsion, I can compel the ring to shoot rapidly away, leaving the train either to break up irregularly or to form by its own motion a second smaller ring, as in the case of discharges of air.

The rings thus formed in the midst of the liquid will, of course, differ in size, according to the amount of liquid expelled at each impulse. As, however, this is never so small as a drop, and

the velocity of the action is comparatively great, the rings thus formed are always larger than those resulting from the dropping process. They are, therefore, better suited for observations on the internal motions and duplicate structure of the liquid ring. It is essential in such observations, however the ring may be formed, to make use of a partially transparent liquid, such as a dilute solution of sulphate of indigo, or a thin mixture of cobalt blue, and to view the ring by a moderately strong light. In these circumstances the double spire and the horizontal bands become beautifully apparent.

14. *Origin of the liquid ring, and of its rotation.*—Considering the entire agreement in structure and motions of the liquid ring as compared with the mechanically formed ring of air, it is natural to conclude that similar conditions of force are concerned in their production. Such is evidently the fact with rings generated by the process last described, that is, when the orifice is at or below the level of the reservoir. Here, the impulse of discharge acting downward and laterally, and the resistance of the aperture and of the contiguous medium acting backwards, present a combination of forces precisely such as, according to the previous explanation, operates in the production of the rings of air.

In regard to the formation of rings by the dropping process, the mechanical conditions, although apparently different, are such as I think would naturally give rise to the same combination of motions. In considering the mode of action of the drop it is proper to distinguish between the case of a drop which *impinges upon the surface* of the medium with a sensible velocity and that of one *simply laid upon it* from the beak of the dropping tube. The former strikes the medium with the acquired momentum, and penetrating into it as if through a circular aperture, forms an advancing column whose central parts are carried forward, while the sides are relatively retarded by the resisting action of the contiguous fluid. Under these conditions, the forces brought into play and their resulting motion must evidently be the same as in the case of an impulsive discharge of liquid from the immersed beak of the pipette.

In the other case, that is, where the drop is simply laid upon the liquid plane, the gravity of the matter of the drop and the tension of the curved surface unite in giving a downward impulsion to its contents. At the same time, the surface of contact with the fluid beneath, forming, as it were, a rapidly enlarging circular aperture, secures the symmetry of the moving mass. This, as it advances, will of course be subject to the same moulding action of the impulsive and retarding forces which has just been described, and which, as we have seen, imparts to rings of air and water formed by mechanical discharge their identity of structure and motion.

ART. XXXIV.—*Correspondence of M. Jerome Nicklès, dated Paris, June 30th, 1858.*

Equivalents of elements.—DUMAS has given us reason to expect from him a work on the various questions connected with equivalents and atomic volumes, upon which he first published in 1822. While looking forward to the full publication, he has just communicated to the Academy some new results of his researches.

Among the simple bodies or elements studied by him, 22 have equivalents that are multiples of hydrogen by a whole number; viz:

O	8	N	14	Bi	214	C	6	Li	7	Cd	56
S	16	Ph	31	Fl	19	Si	14	Na	23	Sn	59
Se	40	As	75	Br	80	Mo	48	Ca	20		
Te	64	Sb	122	I	127	Au	92	Fe	28		

Seven have equivalents which are multiples of *half* an equivalent of hydrogen.

Cl	35·5	Mn	27·5	Ni	29·5	Pb	103·5
Mg	12·5	Ba	68·5	Co	29·5		

Three have equivalents which are multiples of *one-fourth* of an equivalent of hydrogen.

Al 13·75 Sr 43·75 Zn 32·75

Among the comparisons that may be made there are the following:

N	14	Ph	31	As	75	Sb	122
Fl	19	Cl	35·5	Br	80	I	127

It is seen that on adding 108 to the number for nitrogen we have the number for antimony (14+108=122); and adding it to the number for fluorine, we have the number for iodine (19+108=127).

So also on adding 61 to the equivalent of nitrogen we obtain that of arsenic (14+61=75); and the same to that of fluorine, gives that of bromine (19+61=80).

In a word, if the numbers be arranged on two parallel lines, the ordinates of one series lengthened by 5, become the ordinates of the other, with the single exception of phosphorus and chlorine, which are separated by 4·5 instead of 5. These facts teach the propriety of arranging the metals in series, that shall show a double parallelism; for such a classification brings out to view the various analogies existing among them. In fact, when arranged by natural families, each of the elements is in proximity to two others, belonging to two related families; and these related families occupy the two lines next to that containing the metal selected for comparison. Finally, each metal is surrounded in such a table by four others, which are united to it by analogies of different kinds and more or less close.

Artificial minerals.—By the reaction at a high temperature of volatile fluorids on certain oxygen compounds, Messrs. H. St. Claire Deville and Caron have easily obtained large crystals of white and green corundum, ruby, sapphire, zircon, chrysoberyl, spinel and staurotide. The last, a silicate of alumina, was obtained in two ways; either by decomposing fluorid of aluminium by silica, or fluorid of silicium by alumina. The

general method may be explained by a brief statement of that for white corundum.

Into a carbon crucible put some fluorid of aluminium; and over it adjust a small carbon cupel filled with boracic acid: then having put on the cover and protecting the crucible from the action of the air, subject it to a white heat for an hour or so. The vapors of the fluorid and boracic acid, meeting in the free space in the crucible over them, decompose one another, and afford corundum and fluorid of boron. The crystals are rhombohedral with the prismatic and basal planes of a hexagonal prism; they are optically negative and have all the other physical qualities of corundum. Large crystals over a centimeter long and very broad have been obtained, but they want thickness.

To form the ruby or red corundum, it is only necessary to add a little fluorid of chromium to the fluorid of aluminium: and the blue corundum or sapphire is obtained under the same circumstances, the only difference being that it contains extremely little of chromium in some unknown state. With much oxyd of chromium, the corundum is of a fine green color.

Permian rocks in North America.—On the 10th of May last, the Academy of Sciences received a letter from Dr. Shumard, announcing his discovery of Permian fossils in the Guadalupe Mountains, New Mexico. M. d'Archiac observed on the reading of the communication, that the first identification of the Permian in the Rocky Mountains, was due to a Frenchman, Jules Marcou, who was connected with an expedition under Captain Whipple in 1853, which crossed the Rocky Mountains from the Mississippi to the Pacific through New Mexico. The rocks were observed by him to the northwest of the locality mentioned by Dr. Shumard, between the River Colorado Chiquito (lat. 35° 18′ 43″, long. 110° 49′ 56″), and the Sierra de Magoyon, underlying a series of beds referred to different stages of the Trias; the beds were a magnesian limestone and he compares it to the magnesian limestone of England. Its thickness was about 325 yards; the fossils, although abundant, were too imperfect for determination.*

M. d'Archiac added further, that Prof. Emmons has also referred to the Permian System certain deposits in North Carolina that lie below rocks of the age of the Richmond coal bed. He has even found the lower jaw of a species of Insectivorous mammal (Dromatherium sylvestre), with remains of thecodont Saurians in the Chatham coal basin of the same state, below beds containing plants which he refers to the age of the "Marnes irisées" (upper Triassic). But as nothing seems to prove that the beds are really older than the overlying marls, this mammal may be no older than the *Microlestes antiquus* of Wurtemberg.

* Note by the Editors.—This claim for Mr. Marcou we believe is quite unfounded. Any geologist knows that pronouncing upon the age of a rock, in an unexplored region, on mineral characters alone, or without well determined fossils is no credit to the reputation of a geologist. Marcou has given in his report no evidence from fossils as to the so-called *Permian*. Moreover the species of fossils, out of which he has made his *Jurassic*, have been shown to be *Cretaceous*, and his *Triassic* was based on no better evidence than his Permian. The whole was a hazardous guess; and as far as facts have been ascertained not right at that for the particular localities visited by him. We shall touch on this subject again in our next number.

Oysters: resupplying the oyster banks of France.—The trade in oysters in France has so declined that unless there is some speedy remedy, it will soon entirely cease. Out of 23 banks of oysters which have been in successful exploration on the coast of Rochelle, 18 have been completely ruined, and the others injured, by the invasion of muscles. The same is true of other beds along the Atlantic and Mediterranean shores. The French government proposes to undertake the resupplying of the beds, and we cite the following from the Report on the subject by the Zoological Section of the Academy of Sciences.

Each oyster may produce 1,000,000 to 2,000,000 of young. If, out of this number, twelve remain on the shell of the mother, it is all that can be expected in years of abundance. The number that becomes attached is therefore almost nothing compared with the number lost; and the problem consists in finding a means of detaining this small proportion of the ova at the bottom for the purpose of peopling it. The following method has been put in practice by several amateur zoologists, and among them, by Mr. Carbonnel, Mr. Mallet and Mr. Ackermann. It consists in letting down over the beds a frame work made of branches stripped of their bark, and spread out flat so as to be no obstacle to navigation. The brood of developed ova will rise like a cloud of powder across these entwined branches, and the embryos encrust them on all sides. The frame-work is to be left in place not only during the time of reproduction, but, until the young are sufficiently large to be removed for peopling other beds. The pieces of frame-work thus loaded with young may be carried by vessels wherever desired. After some time, the young shells will detach themselves and fall to the bottom which had been previously prepared for them by means of the drag. This transfer should be made in February or March, because at this time, the young oysters deposited on the branches of the frame-work are large enough to be easily seen.

The dragging for oysters in France usually begins in the month of September. The commission propose to make February or March the time for opening the fisheries, for when, in July, it is attempted to ascertain which beds are in a condition to be opened, all the oysters have not yet laid their eggs, and the product from those which have is not visible to the naked eye.

The government has not yet determined on any course of action; but as a commencement, has given the Report general publicity, in order to draw to it the attention of practical men.

Garden for the Acclimation of Animals.—The "Société Zoologique d'Acclimatation" has been till recently without any convenient grounds in the vicinity of Paris. Paris has now appropriated to the Society 15½ hectars (nearly 40 acres) of the "Bois de Boulogne," with the commission to form a society for establishing and sustaining a zoological acclimating garden, for multiplying and supplying to the public, species of animals or plants, useful or otherwise desirable, which have recently been, or may hereafter be, introduced into the country. To obtain capital for the society, it has made an appeal to all who may be ambitious of adding to our stock of animal or vegetable wealth. The sources of income will be,

1st, the proceeds from tickets issued to visitors to this garden of rare and strange plants and animals; 2dly, the proceeds from the sale of animals, eggs, plants or grains obtained in the establishment or by its means, which will all be of ascertained purity and at the same time very rare.

The past history of the Society of Acclimation is a sufficient warrant for its future success. A few of its services may here be mentioned. In 1854 it purchased half of the only herd of yaks which had come to Europe; and now the yak, through its care, has become acclimated without difficulty, and has prospered. In 1855 it distributed nearly a million of bulbs of the yam (*Dioscorea Batatas*); now the yam is cultivated at large over Europe, and it promises to rival the potato, when through successive sowings it shall have lost its long form. The Society has spread everywhere the Sorghum sugar cane, (*Holcus saccharatus*,) which already furnishes to the departments of middle and southern France abundant forage of good quality, while at the same time, through its saccharine juices, it promises to be as valuable to the southern provinces of France as the beet to the northern. It has procured young plants of the *Loza*, a species of *Rhamnus*, from which the Chinese extract the fine green color called the *Kao*. It has imported two herds of Angora goats, which reproduce perfectly in Europe without manifesting any symptoms of degenerating. It has not only acclimated the silkworm of the Ricinus, (*Bombyx Cynthia*, or Palma Christi silkworm, a native of India,)* which is already in France to its 25th generation, but it has done more, in succeeding in varying its nourishment, by substituting the leaf of the very common *Fuller's Teasel* (*Dipsacus Fullonum*) for the Ricinus (*R. Europæus*) which is rare and does not grow in our climate without great care; and it has almost succeeded in regulating the time of hatching, so as to make the birth of the worms correspond with the development of the leaves on which they are nourished. It has already nearly accomplished the propagation in the open air of a silkworm living on the oak. It has raised in the Jardin des Plantes two new kinds of Chinese oaks. It has undertaken to grow the white nettle of China, with which fabrics may be made more firm than those of linen or the indigenous hemp. It has promoted the culture of the oleaginous pea, excellent as food and affording an abundant oil. It has received in portable green-houses the wax tree and varnish tree in good condition, with the insects which frequent them. Finally, through M. D. de L'Huys, its Vice President, it has succeeded in procuring from the slopes of the Cordilleras numerous tubercles of potato, in order to renew in Europe this so valuable species, which through exaggerated culture and long-continued disease has lost a part of its qualities.

If all these results have been secured, without even a small garden, what may be attained when the society shall have secured large grounds, where men shall be constantly devoted to raising, multiplying, studying and improving new species that may be introduced, and where the public shall be able to see and avail themselves of the great success?

Alcohol from Sorghum.—We return to a subject of which we have often spoken to mention a new fact. M. Leplay has been investigating the Sorghum (Holcus saccharatus). He has experimented on more than a thousand kilograms of it, and has continued his labors for two months.

* See this Journal, [2,] xix, 108, and xx, 288.

He has recognized, 1st, that the quantity of solid matter which the stems of Sorghum give on drying augments gradually and quite regularly, from the formation of the panicle (flowering) to the maturity of the grain, whatever the soil; 2d, this solid matter accumulates in the juice and not in the insoluble part of the plant; 3d, when the stem is still green and the panicle scarcely formed, it contains only a little sugar; the sugar is developed as the plant advances and the grain approaches maturity, and hence the composition of the stem and the production of the saccharine matter depend entirely on the state of the plant, and not on the epoch of its cultivation; 4th, in the juice of the Sorghum, before its maturity, in which the saccharimeter can discover little or no sugar, fermentation indicates between 32 and 100 grams of sugar per litre; but as the grain advances towards maturity, there is a gradually increasing deviation to the right in the polarizing apparatus, caused by the cane sugar present, and when the grain is ripe the quantity of cane sugar indicated by the polarizing apparatus is but little less than the sugar indicated by the fermentation.

On desiccation, the Sorghum loses 70 per cent of its weight. In this state it can be preserved, and so used in the manufacture throughout the year. Mr. Leplay carries on the fabrication with little cost, and observes that it is easily done with apparatus that may be carried from place to place.

Angora Goats.—The acclimation of the Angora goat* has been completely accomplished. The goat is now living and at large in the Vosges, Jura, Cevennes, Alps, mountains of Auvergne and Aveynon, and the Black Forest. It prospers marvelously in Algeria, as the Report before us attests. The Angora goat was introduced there in 1856; the flock consisted of ten individuals, four males and six females; it has so prospered as to consist now of forty-six individuals, eighteen males and twenty-eight females, and none are at all degenerated from the original stock; the silky hair has lost nothing of its lustre, and affords fine velvets every way comparable with the silk velvets, and even superior to them, as it does not mat with pressure or friction. M. Bernis, veterinary of the army in Africa, to whom this flock has been intrusted, proposes to produce a mixed breed between the goat of the country and some of the females of the Angora, (which are in excess in the flock,) and so establish a new variety. The trial has already been made in France, and a mixed breed obtained of very rustic appearance, with hair inferior in quality to that of the pure Angora.

Electric discharges produced in air highly rarified.—On making a current of static electricity to pass through a tube of rarified air, a luminous arc is obtained, which experiences modifications when subjected to the action of the poles of a powerful magnet. This fact, which calls to mind the corresponding effect experienced by a luminous arc produced by a powerful galvanic battery, was discovered by De la Rive in 1849. He first used as the source of the electricity the hydro-electric machine of Armstrong, afterwards a common electric machine, and quite recently Ruhmkorff's apparatus. M. Plücker, of Bonn, has tried the same, and his results are published in a recent number of Poggendorff's Annalen.

According to De la Rive, it is necessary for success that the tube or globe should contain some vapor, equivalent in tension to six millimeters

* See this Journal for November, 1855, p. 405.

of mercury, and the vapors answering best are those of alcohol, sulphuret of carbon, and camphene. De la Rive has applied the experiments to the illustration of the Aurora Borealis, so frequent in the Polar regions. A recent discovery has been made, bearing on this theory, by Dr. Robinson, who has found that the light of the Aurora Borealis possesses the property of rendering substances fluorescent which are susceptible of it. The material on which he experimented was sulphate of quinine.

On raising sunken vessels.—In a former communication, some years since, we spoke of the experiments made by Messrs. Fèvre and Giannetti towards raising by means of balloons filled with carbonic acid sunken vessels or other bodies. Carbonic acid was proposed because it could be so easily procured. But a civil engineer, Mr. Marrassieh, has proposed to employ atmospheric air, and his apparatus has had the approval of many good judges. The object has long engaged much attention and has had its interest greatly enhanced by the war in the Crimea. The new system has consequently been made the subject of a Report by the Academy of Sciences, which is quite favorable, and from which we cite a few words.

The air balloons proposed by Mr. Marrassieh are made of the prepared caoutchouc called artificial leather. They are carried to the bottom empty, and secured to the sunken object by divers, and then they are filled with air by forcing pumps, worked by means of steam upon a steamboat—an indispensable auxiliary in such operations.

A girt of these balloons is put around the submerged body, the balloons being united together by tubes; but there are stopcocks to shut off the communication between them, so that accident from rupture is confined to the one in which it may occur.

Anesthesis by carbonic acid.—We have explained, during the year past, the experiments of Simpson and Follin on the use of carbonic acid for local anesthesis. We now have to report on the effects of its inhalation when mixed with a certain quantity of air, as observed by Mr. Ozanam, who proposes its use for man. He states that the effects of carbonic acid are quite similar to those of ether, but more fugitive; and while with the latter, the inhalation should be interrupted at intervals, with carbonic acid, the reverse is true. He affirms:

a. As long as it is wished to prolong the sleep the inhalations should be continued.

b. They may be continued ten, twenty, thirty minutes and more, without danger to life.

c. On ceasing the inhalation, waking is almost immediate.

In these experiments no case of sudden death has been observed, as with chloroform. When death is in prospect, as Dr. Fèvre has observed, it comes slowly, and may be foreseen for a long time in advance, and its progress noted, according to his experience, by the state of the heart and that of the pupils. The following experiment, reported by Mr. Ozanam, is highly interesting:

"I prepared a gas-bag containing 100 litres of carbonic acid, and resolved to continue the anesthesis as long as was possible. The animal was asleep at the end of three minutes without convulsions, and so remained, extended on its side. The inhalations were continued for eighty-seven minutes, and then the apparatus was withdrawn. The sleep was prolonged afterwards for five minutes; towards the tenth minute the legs commenced to

shake; at the fifteenth the animal was up again; and thus 102 minutes were used in the whole experiment—a length of time much beyond what the longest operations would require."

Messrs. Fèvre and Ozanam have respired the gas several times,—if not to the production of sleep, at least to feeling its first effects. They say its taste is slightly pungent, and as agreeable as that of ether; it excites salivation. They propose its adoption in surgical practice, as the least dangerous method, and as sufficiently efficacious.

Variation of color in the venous blood of the glands.—Since the discovery of the circulation of the blood, it has been admitted that the blood of the arteries is red and that of the veins black, with this exception that it is the reverse for the arteries and pulmonary veins. This fact has afforded Bichat the foundation for his grand division of the circulation, (since adopted by all anatomists,) a vascular system with *red* blood, which carries the blood from the lungs to all parts of the body; a vascular system of *black* blood, which carries the blood from all parts of the body to the lungs. But it results from the researches of Prof. Claude Bernard that this statement cannot be accepted absolutely. This skilful observer has proved, through a great number of dissections of living subjects, and in a manner which leaves no room for doubt, that the blood contained in the renal veins is sometimes black and sometimes red, and that when it has the latter color, it is black in the inferior vena cava which receives the blood from the renal vein.

This fact being established, he looked for an explanation, and found that it was due to the state of repose or activity of the kidneys, the secretory organ of the urine. He has, in fact, demonstrated, by delicate experiments, in his course of Physiology at the College of France, that when the urine runs from the kidneys, where it has just been formed, in the ureter which takes it to the bladder, the blood contained in the renal cavities is red; and that it becomes black when the flow ceases.

The same experiment performed on the submaxillary gland of the dog produced the same result. Flowing of saliva by the proper duct from this gland, and presence of red blood in the afferent vein are two phenomena which go together, as also the absence of saliva and black color of the blood in the same vein. Analogous experiments made on the parotid gland and on the glands in the abdominal parts of the digestive tube, have given similar results. But the author adds, with the habitual severity which he brings to his conclusions, that the study will be complete only when the examination shall have been extended to every gland throughout the structure.

It results from the facts, that if, as regards physiological conditions, the term *red blood* may be applied to the *arterial blood*, that of black blood cannot be used in so general a way for the venous blood. It results also from other researches of Prof. Bernard that physical and chemical modifications correspond to these different states of coloration, and ought to be taken into consideration in the analyses of the blood, the composition of which varies even with the state of activity or repose of an organ. This last principle applies not merely to the glands, but to all the organs of the body, so that it will be necessary to study now the venous blood in the state of repose, and in the state of functional activity. It is worthy of remark that if the blood goes out red from the glands in activity, it

goes out, on the contrary, very black, and with different physical qualities from a muscle which contracts itself.

In experimenting on the submaxillary gland, Prof. Bernard has been able, by means of electricity, to excite at will the activity of an organ, so as to produce the secretion of saliva and the coloring of the blood of the vein red. This fact suggested to him the following remark: "All those modifications which the blood undergoes in consequence of the functional activity of the organs, are always determined by the nervous system; and consequently, at this point of contact between the organic tissues and the blood, we must search for a knowledge of the special agency of the nervous system in the physico-chemical phenomena of life."

Society for the Aid of the Friends of Science.—This Society, the formation of which we announced last year, as the suggestion of Mr. Thenard, held its first session on the 15th of last April. It is in full prosperity and numbers now 1400 subscribers. It has already aided many persons in need, and gives an annual pension to four families of men of science, among them those of Laurent and Gerhardt. No condition of residence is prescribed to Madam Laurent or Madam Gerhardt, who were not born in France, and they are therefore free to go where they choose, without losing the right to the pension. Madam Laurent is of the Duchy of Luxembourg, and Madam Gerhardt of Edinburgh, Scotland, a daughter of Dr. Sanders. It is probable that these ladies will not take advantage of the privilege, but will remain in France, to superintend the education of their children which is given gratuitously in a department of the University.

Since the death of the President, Thenard, another has been elected, and the officers are now as follows:

President, Marshal Vaillant, Member of the Institut.—*Vice Presidents*, Dumas, Flourens, and De Senarmont.—*Secretary*, De Senarmont.—*Vice Secretaries*, Barreswill and F. Boudet.—*Censors*, E. Delessert, Baron Seguier, Paul Thenard.—*Treasurer*, Paul Seguin, Civil Engineer.

Besides, the Society has a Council of Administration in which some scientific and industrial notabilities figure,—among them, Elie de Beaumont, Boussingault, Geoffroy St. Hilaire, Poncelet, Dolfus, (President of the Industrial Society of Mulhouse), Schattenmann, (Director of the Manufacture of Chemical Products of Bouxwiller, Bas-Rhin), etc.

The "Compte Rendu" of this year will soon be published with a list of the subscribers.

Bibliography.

MALLET-BACHELIER, *Paris, has recently published:*

Annales de l'Observatoire, vol. iii, in large 4to.—This volume contains a Treatise by Yvon Villarceau, On the determination of the Orbits of Planets and Comets, and two by LeVerrier entitled *Theory of the Periodic Comet of* 1770, and *Construction of tables of the Movements of the Planets.*

Cours d'Analyse de l'Ecole Polytechnique par Sturm, publié par Mr. Prouthet, vol. i, in 8vo.—This first volume is a reprint of the Lectures of Sturm in the Polytechnic school,—lectures which have had great reputation.

Tables de Logarithmes à 5 decimàles, par Hoüel, 1 vol. in 8vo.—These tables which are in part a reproduction of those of Lalande have been

made more convenient for use by several modifications derived from works published in other countries.

HACHETTE, *rue Pierre Sarrazin, Paris.*

Du Moncel: Etude du Magnetisme et de l'Electro-magnetisme, 1 vol. in 8vo.—This is the only work which is completely up to the most recent discoveries or published experiments in electro-magnetism, a department which has been made a subject of special study by the author.

Général Morin: Aide-Mémoire de Mecanique pratique, 2nd edition, 1 vol. in 8vo.—This work is indispensable to constructors, mechanicians, and even to physicists. It contains the principal formulas useful in practice, besides information on the subjects of density, friction, dilatation, resistance of materials, etc.

Gustave Heuzé: Matières fertilisantes, engrais solides, liquides, naturels et artificiels, 1 vol. in 8vo.—This work is a publication of the Course of practical Agriculture which Professor Heuzé gives with great success at the celebrated School of Agriculture at Grignons.

Alfred Maury: La Terre et l'Homme, in 12mo.—Contains information of indispensable importance in Ethnology, Geology, Mineralogy, Species and Races, and Geography in general.

At the BUREAU DE L'AMI DES SCIENCES, 9 *Rue Cassette, Paris.*

Victor Meunier: Essais Scientifiques, 2 vols. in 12mo.—V. Meunier is the founder and director of a weekly sheet entitled *L'Ami des Sciences*, (The Friend of Science), which aims to popularize the more important scientific facts. The two volumes entitled *Scientific Essays* have for their object the scientific reconstruction of society and the removal of abuses, which are connected according to the author with education. The author writes with extraordinary fervor, touching upon great questions and bringing out cruel truths. He entitles the first volume, "Apostolat Scientifique." The second treats of the improvements to be brought about in Architecture, Agriculture, and Navigation. It is impossible to read a work written with so much earnestness, without interest.

Louis Aubert, Civ. Eng.: Sur les Moyens de préserver les Navires des desastres causés par les Abordages, a pamphlet with lithographic illustrations.—Mr. L. Aubert is admitted to be the inventor of the floating batteries which contributed so much towards ending the war in the Crimea. This new memoir contains a continuation of the ideas which were published by him in 1852 on the occasion of the work just alluded to.

At Strasbourg, at the Bookstore of DERIVAUX.

Zoologie du Jeune Age, ou Histoire Naturelle des Animaux, par A. Lereboullet, Professor de Zoologie à la Faculté des Sciences de Strasbourg.—This work, written especially for youth, is an attractive exposition of the principal facts relating to the Natural History of Animals. The beautiful plates colored by Silbermann's process, contribute much to increase the interest of the volume, the first two parts of which have been issued. It will be adorned by 320 colored figures of animals, and will appear in 32 parts, at 50 centimes (or about 10 cents) each.

V. MASSON, *Place de l'Ecole de Médecine, Paris.*

J. Nicklès. Le Moteur des Convois des grands tunnels, et en particulier du Tunnel Sous-marin, a pamphlet of 32 pages in 8vo.—The subject of this work has been indicated in our last communication.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the Nature of Flame, and on the Condition of the Sun's Surface;* by JOHN W. DRAPER, M.D., Professor of Chemistry and Physiology in the University of New York.—(L., E. and D. Phil. Mag., vol. xv, p. 90.)—Among the recent publications on photo-chemistry, there is one by Professor Dove on the Electric Light (Phil. Mag., Nov., 1857) which will doubtless attract the attention of those interested in that branch of science. Examination by the prism, and by absorbing and reflecting colored bodies, leads him to the conclusion that it is necessary to consider the luminous appearance as having two distinct sources:—1st, the ignition or incandescence of the material particles bodily passing in the course of the discharge; 2dly, the proper electrical light itself. As respects the first, he illustrates its method of increase from low to high temperatures, by supposing a screen to be withdrawn from the red end of the spectrum through the colored spaces successively towards the violet; and that of the latter from the bluish brush to the bright Leyden sparks, by a like screen drawn from the violet towards the red.

The true electric light exhibits properties resembling those observed in actual combustions, as though there was an oxydation of a portion of the translated matter when the spark is taken in air. The order of evolution of rays in this instance happens to be the same as in the second illustration of Professor Dove, that is, from the violet to the red. There are certain facts connected with these appearances of color which are not generally known, and deserve to be pointed out.

In the Philosophical Magazine, (Feb., 1848,) I showed experimentally that there is a relation between the color of a flame and the energy with which the combustion giving rise to it is going on. The more vigorous and complete the combustion, the higher the refrangibility of the light. A flame burning in its most tardy and restricted way, emits rays that are red; but burning in its most complete and effective manner, rays that are violet. In intermediate states of combustion, the intermediate colors are evolved in their proper order of refrangibility.

The flame of a candle or lamp consists of a series of concentric luminous shells, surrounding a central dark core. These shells shine with different colors, the innermost one immediately in contact with the dark core being red, and having a temperature of 977° F. Upon this, in their proper order of refrangibility, are shells the light of which is orange, yellow, green, blue, indigo, violet. When we look upon such a flame, the rays issuing from all the colored strata are received by the eye at once, and impress us with the sensation of white light.

The differently colored shells of which a flame thus consists, may be easily parted out from one another, and demonstrated by a prism. Their cause is the slower rate at which combustion occurs at points more and more towards the interior. On the outside, which we may say is in contact with the air, the combustion is most vigorous and complete, and hence the light there emitted is violet; but in the most interior portion of

the shining shell, resting upon the dark combustible matter, the atmospheric air can hardly penetrate, or rather its oxygen is exhausted and consumed. Between the exterior and interior surface, the burning is going on with an activity constantly declining, because the interpenetration or supply of oxygen is gradually less and less.

But besides this collection of colored shells, constituting what may be termed the actual flame, there is another region exterior thereto, and to be distinguished both in its chemical nature and in its optical relations. Chemically, it consists of the products of combustion and of the unburnt residue of the air, that is to say, carbonic acid, steam, and nitrogen. These are all the time escaping out of the true flame, and envelop it as an exterior cone or cloak. Optically, this portion differs from the true flame in the circumstance, that it is shining as an incandescent, ignited, but not a burning body. For physiological reasons, into the detail of which it is not necessary here to go, the tint of this exterior cloak seems to be a monochromatic yellow. That, however, is to a considerable degree a deception, prismatic examination proving that all the other colors are present, and that the yellow merely exceeds the rest in force or intensity.

A flame thus far may be considered as offering three regions:—1st, a central nucleus, which is not luminous, and consists of combustible vapor; 2dly, an intermediate portion, the true flame, arising from the reaction of the air and the combustible vapor, and being composed of a succession of superposed shells, the interior being red, the exterior violet, and the intervening ones colored in the proper order of refrangibility; the cause of this difference of color being the declining activity with which the combustion goes on deeper and deeper in the flame. As to temperature, the inner red shell cannot be less than 977° F., and the exterior violet one probably more than 2500° F. 3dly, an envelop consisting of the products of combustion, exterior to the true flame, shining simply as an incandescent body, and its light for the most part overpowered by the brighter portion within.

By the aid of the facts thus presented, we can easily explain the nature of the other regional divisions distinguishable in such a flame. There must be a blue portion below; blue, because it consists of the most refrangible rays, which issue forth in abundance, for there the exterior air is most copiously and perfectly applied. At the upper end of the flame, particularly if the wick be long and the supply of combustible matter abundant, the light emitted is red, for the products of combustion ascending past that part, make it difficult for the exterior air to get access.

Upon these principles we may also predict what color a flame will have when we vary the circumstances of its burning. Tallow or wax at temperatures greatly beneath their usually understood point of combustion, oxydize with a pale violet phosphorescent light, quite perceptible nevertheless in a dark room; and here the light is violet, for the supply of combustible matter is small, and that of the air abundant. The oxydation is therefore thorough and prompt. For a like reason, sulphur, as we commonly see, burns blue; but if a piece of it is thrown into nitrate of potash ignited in a crucible, the light yielded is of intolerable brilliancy,

and absolutely white. Its whiteness does not depend upon the physiological fact, that any color, if it be intensely brilliant, will seem white to the eye; but it is optically white, as is proved by prismatic examination, when all the colors are perceptible. And the reason of this is, that at the high temperature to which the sulphur is exposed, it volatilizes faster than the nitrate of potash and air together can oxydize it, and offers every intermediate rate of combustion, and emits rays of every refrangibility.

In like manner it may be shown that carbonic oxyd must burn with a blue flame, and cyanogen with a red. We can also foresee what must be the optical result of resorting to unusual methods of combustion, as when we throw into the interior of a flame a jet of air from a blowpipe. In this case we destroy the red and orange strata, replacing them by bluer colors. Examining such a blowpipe cone by the prism, we have a beautiful demonstration that such has actually taken place.

There is one of these special cases which deserves attentive consideration in connection with the appearance of the electric light: it is the production of Fraunhoferian lines, when things have been arranged in such a way that an incombustible material is present in the substance to be burnt. This state is perfectly represented in the case of cyanogen, which contains more than half its weight of incombustible nitrogen. When the peach-colored nucleus of the cyanogen flame is properly examined, it yields a series of dark lines and spaces exceeding in number and strength those of the sunlight itself. These fixed lines are the representatives of dark shells, superposed among the shining ones with definite periodicity. In such a cyanogen flame they bear no relation to the burning of the carbon, but must be attributed to the disengagement of the nitrogen.

In other cases dark lines are replaced by bright ones, as in the well-known instance of the electric spark between metallic surfaces. The occurrence of lines, whether bright or dark, is hence connected with the chemical nature of the substance producing the flame. For this reason they merit a much more critical examination than has yet been given them, for by their aid we may be able to ascertain points of great interest in other departments of science. Thus if we are ever able to acquire certain knowledge respecting the physical state of the sun and other stars, it will be by an examination of the light they emit. Even at present, by the aid of the few facts before us, we can see our way pretty clearly to certain conclusions respecting the sun. For since substances which are incandescent, or in the ignited state through the accumulation of heat in them, show no fixed lines, their prismatic spectrum being uninterrupted from end to end, it would appear to follow that the luminous condition of our sun, whose light contains fixed lines, cannot be referred to such incandescence or ignition. At various times those who have studied this subject have offered different hypotheses: one regarding the sun as a solid or perhaps liquid mass in a condition of ignition; another considering the light to be electrical; a third supposing it to be the seat of a fierce combustion. Of such hypotheses we have given reason for declining the first. Prismatic analysis, which demonstrates no resemblance between the light of the sun and that of any form of electric discharges with which we are familiar, enables us in like manner to reject the second; and upon the

whole, facts seem most strongly to prepossess us in favor of the third, in artificial combustions similar fixed lines being observed. If such is to be regarded as the physical condition of the sun, we can no longer contemplate it as an immense mass slowly and tranquilly cooling in the lapse of countless centuries by radiation into space, as so many considerations drawn from other branches of science have hitherto led us to suppose, but it must be regarded as the seat of chemical changes going on upon a prodigious scale, and with inconceivable energy.

If the law designated above, that the more energetical the chemical action in combustion the more refrangible the emitted light, be translated into the conceptions of the undulatory theory, it not only puts us in possession of a distinct idea of the manner in which the combustive union of bodies is accomplished, the quickness of vibration increasing with the chemical energy, but it also enables us to transfer for the use of chemistry some of the most interesting numerical determinations of optics.

2. *Fluosilicates and Fluostannates.*—Marignac has found that the fluosilicates are isomorphous with the fluo-stannates. The fact is regarded as demonstrating that the formula of silica is SiO_2 in place of SiO_3.

3. *On Fluorescence produced by the Aurora;* by T. R. Robinson, (in a letter dated Armagh, March 24, 1858, and cited from the L., E., and D. Phil. Mag., xv., p. 326.)—On the 14th instant an aurora was visible here of more than the average brightness. At 11 P. M. it showed an arch extending from W. to N.E. by E., which emitted a few yellow streamers; and the sky above it was covered with diffused light, over which brighter portions flickered like waves, extending several degrees beyond the zenith. I availed myself of the opportunity to try whether this light was rich in those highly refrangible rays which produce fluorescence, and which are so abundant in the light of electric discharges; and I found it to be so. A drop of disulphate of quinine on a porcelain tablet seemed like a luminous patch on a faint ground; and crystals of platinocyanid of potassium were so bright that the label on the tube which contained them (and which by lamplight could not be distinguished from the salt at a little distance) seemed almost black by contrast.

These effects were so strong in relation to the actual intensity of the light, that they appear to afford an additional evidence of the electric origin of this phenomenon, and as such I hope they may interest some of your readers.

4. *The Air-balance, a new form of Barometer, for weighing atmospheric fluctuations;* by J. B. James, M.D.—Reflection upon the action of a barometer said to have been in use for some time past in the observatories of Liverpool and Rome, which has that portion of the tube not immersed balanced upon a lever, the motion of which indicates the changes, has suggested an arrangement which it is believed is new, and by which minute changes in the pressure of the atmosphere may be weighed with great accuracy.

Let the barometer tube be fixed over a platform, with its lower end freely exposed; let the platform also support a balance, one arm of which being placed directly under the lower end of the tube, supports the reservoir containing the surplus mercury; in this the lower end of the tube is immersed in the usual manner. If now the other arm of the balance be weighted, to counterpoise the reservoir and the mercury not supported

by the atmosphere, the alteration which change of atmospheric pressure renders necessary in the counterpoise, indicates the change of pressure which has occurred.

Several circumstances require attention, besides delicacy in the balance and accuracy in the weights, to secure accuracy in the results. 1st. The tube must be of uniform capacity throughout its length, excepting so much as is immersed in the mercury; varying capacity in the different portions of the tube will be productive of error by the alterations which change of temperature produces, even if the vacuum chamber be uniform. 2d. An alteration of either the temperature of the mercury or the atmospheric pressure, will require a re-adjustment at each successive observation by elevating or depressing the support of the balance or the tube in such manner as to cause the immersion of the tube in the mercury to the same point to which the first adjustment was made; the immersion of more or less of the tube will cause an error in the result. For this purpose two balances may be used; upon one the tube may be balanced in the manner first alluded to, by which the point of immersion is determined, the reservoir-balance being fixed in its normal position for that purpose; the tube-balance being now fixed, the other is freed and brought to the same position by weights: thus the mercury need not be seen in any part of the operation. This adjustment would probably be facilitated if a short piece of iron or platinum tube of small diameter were attached, which would displace less mercury and prevent to some extent a fluctuation of the column of mercury caused by the motion of the balance. 3d. If very great accuracy is desired, it may be requisite that the arms of the balance be symmetrical and bear equal and similar surfaces, so that change of temperature or atmospheric pressure, the accumulation of dust, oxydation of mercury, &c., may affect both sides equally. Variation of temperature will cause an alteration in the diameter of the tube, and be productive of a small error, for which no remedy is suggested.

This instrument, it is obvious, may be so adjusted as to indicate the pressure of the atmosphere in pounds and its parts on the square inch of surface. But as it will often be desirable to compare observations made by it with those of other instruments, it will generally be required that it express the height of the column of mercury: to this end the instrument may be adjusted to a pressure equal, say, to thirty inches of mercury at a temperature of 32° Fahr. If now a tube has been used having a capacity of 1000 grs. of mercury at 32° F. for an inch of its length, which would have a diameter of about ·6 of an inch, each grain will represent the thousandth part of an inch; and if a correction has been made for the capillarity of the tube, all its indications, at whatever temperature, will represent the height of the column at 32° F., and require correction only for the altered diameter of the tube.

A rude instrument has been constructed on the principle here indicated. A barometer tube having a capacity of 100 grs. to the inch, or a diameter of ·18 inch, was suspended over the dish of a U. S. post-office balance, upon a peg, by turning which the tube was adjusted to the surface of the mercury in the reservoir; and this rested upon the dish. Its operation was such as to justify the foregoing conclusions. Of course a scale may be attached which will show in the usual manner the height of the column.

II. MINERALOGY AND GEOLOGY.

1. *Lecontite, a new mineral;* by W. J. Taylor, (Abstract from "Mineralogical Notes" in Proceedings of Acad. Nat. Science, Philadelphia.)—This new and interesting mineral is remarkable as being a double sulphate of ammonia and soda with potash, containing two equivalents of water and yet homœomorphous with the group of anhydrous sulphates. Prof. Dana has very kindly made the annexed measurements of two crystals which I sent to him soon after receiving the mineral from Dr. LeConte. I made a verbal communication on the subject before the Academy of Sciences at Philadelphia on the evening of February 16th, but owing to a mistake, it did not appear in print—though it is recorded in the rough minutes of this meeting—before the May number of the Academy's Proceedings. It was at that time supposed to be a new mineral from the difference of angle found by Prof. Dana between it and other homœomorphous sulphates, and from a qualitative analysis that I made, from which it was considered a double sulphate of potash (the potash I then thought was in excess) and ammonia, and anhydrous (in this judging erroneously from the form).

The composition is now definitely determined by a thorough quantitative examination, which, by the courtesy of Dr. F. A. Genth, I have made in his laboratory, whom I would here thank for the facilities afforded me in the investigation.

Lecontite occurs in crystals varying greatly in size, some being an inch in length and narrow prisms, others short, not exceeding one-sixteenth of an inch and quite broad. The former crystals are more perfect in form than the larger ones, and the angles better defined.

The following are the measurements of Prof. Dana: the crystals, as he mentions, did not admit of measurement by a reflected image, so that it was necessary to use a candle.

Crystallization trimetric; form right rhombic prism—

$i\text{-}\breve{2} : i\text{-}\breve{2} = 115°$

$i\text{-}\breve{2} : I = 160°$ by measurement.

$\frac{1}{4}\bar{1} : \frac{1}{4}\bar{1} = 127°\ 30'—128°$, or over $i\text{-}\bar{1}$, 52°—52° 30′

$I : I$ (calc. from $i\text{-}\breve{2} : i\text{-}\breve{2} =$ { 76° 48′ over $i\text{-}\breve{2}$, 103° 12′ over $i\text{-}\bar{1}$.

The faces I are small and indistinct except on one side.

Taking $\frac{1}{4}\bar{1} : \frac{1}{4}\bar{1} = 128°$ we have $I : I = 103°\ 12'$, $O : 1\text{-}\bar{1} = 117°\ 7'$.

In hardness the crystals are from 2 to 2·5; when free from the exterior organic matter they are clear and colorless; the smaller crystals are partially coated by a very thin crust of organic matter, from the matrix; taste, saline and rather bitter; permanent in the air. Composition:

Ammonia, per cent,	12·94	contains oxygen	3 98	}
Potassa, "	2·67	" "	0·45	} 8·93
Soda, "	17·56	" "	4·50	}
Sulphuric acid, per cent	44·97	" "	26·94	
Water, "	19·45	" "	17.28	
Organic residue, "	2·30			
Inorganic residue, "	0·11			
Phosphoric acid,	*a trace.*			

There is consequently an oxygen ratio of $NH_4O : SO_3 : HO = 8{\cdot}93 : 26{\cdot}94 : 17{\cdot}28$, which is almost exactly as 1 : 3 : 2 from which we have the general formula $RO, SO_3 + 2HO$.

[It may be interesting to mention that there is an artificial salt with a general formula, exactly corresponding to this $RO, SO_3 + 2HO$, and of the same form, which, though rare, has been described by several chemists: it contains no potash, being solely a double sulphate of ammonia and potash with two equivalents of water; it is mentioned in Gmelin, vol. iii, p. 119, (Card. Edit.,) Séguin, Ann. Chem. 91, 219; Reffault, Ann. de Chem. et Phys. 20 (432)—(435) describes the salt and its preparation. Berzelius (3,286) mentions that the crystals are derived from right rhombic prisms.]

This mineral was first brought to this country in January last by Dr. John L. LeConte, on his return from Honduras; he discovered it in the cave of Las Piedras, in the vicinity of Comayagua. It occurs in trimetric crystals, imbedded in a black matrix resembling bitumen in appearance, which Dr. LeConte considers to be the decomposed excrement of bats which infest this cave in great numbers, and have most likely inhabited it for ages; the cave near the entrance was, at the time of his visit, being worked for the nitre, which was obtained "directly by lixiviating the earth taken from near the mouth of the cave." "The matrix containing the crystals merely furnished a black tar-like semi-fluid mass without nitre." On some of the crystals were observed minute hairs of the bats adhering, and I observed more hair when removing the crystals from their matrix.

In honor of Dr. LeConte, who has been the means of adding this species to mineralogy, I propose to call the mineral Lecontite.

2. *Conducting Power of Rocks.—Altitude of Mountains not Invariable;* by Charles Maclaren, (Edin. N. Phil. Jour., vol. vii, p. 170).—Mr. Hopkins of Cambridge has made some rather interesting experiments on the *conductivity* or conducting power of different substances for heat, of which an account was laid before the Royal Society of London in June last. Without attempting to describe his processes, we give his more important results, and in decimals, the conductivity of "igneous rock" (trap or granite, we presume), saturated with moisture, being taken as unity.

Chalk, in the state of *dry powder*,	·056
Clay, " "	·07
Sand, " "	·15
Sand and clay, "	·11

The conductivity of the following rocks is given in two states—*dry*, and *saturated*, with water:—

	Dry.	Saturated.
Chalk, in block,	·17	·30
Oolite rock,	·30	·40
Hard compact limestones,	·50	·55
Siliceous New Red Sandstone,	·25	·60
Freestone,	·33	·45
Hard compact sandstones (Millstone Grit),	·51	·76
Hard compact old sedimentary,	·50	·61
Igneous rocks,	·53	1·00

The effect of *pressure* on the conducting power of substances was also tried, and proved to be almost nothing. A pressure of 7500 lb. on a square inch of beeswax, spermaceti, and chalk, had no appreciable effect. Uncompressed clay, which had a conducting power of ·26, had the same raised to ·33 by a pressure of 7500 lb.

Sandstone, with conducting power of ·5, divided into layers each 1 foot thick, when compared with a similar mass in one block, had its conducting power diminished $\frac{1}{20}$th. When the layers were only 6 inches thick the diminution was $\frac{1}{10}$th. The effect of discontinuity of substance is therefore small. Saturation with moisture, on the other hand, produces generally a great effect, as will be seen on comparing the dry and saturated blocks of chalk, the dry and saturated New Red Sandstone, and again the dry and saturated "igneous rocks."

These facts have a certain bearing on a geological question—namely, the transmission of heat from the interior of the earth to the crust. The oolite, for instance, conducts heat much better than the chalk, the sandstone better than the oolite, the igneous rock better than the sandstone, and in all cases the rock charged with moisture better than the dry rock. But Mr. Hopkins would have added to the value of his paper, if he had ascertained by experiment the quantity of water absorbed by each rock at given temperatures, and whether the conductivity is exactly in proportion to the absorption.

In illustration of the use that may be made of the tables, we would refer to certain remarks made by Dr. Robinson on a paper read by Professor Hennessy at the recent meeting of the British Association. The subject was "The Direction of Gravity at the Earth's Surface." In alluding to certain supposed local and temporary changes of level, he mentioned the following curious fact:—"He found *the entire mass of rock and hill on which the Armagh Observatory is erected, to be slightly, but to an astronomer quite perceptibly, tilted or canted at one season to the east, at another, to the west.* This he at first attributed to the varying power of the sun's radiation to heat and expand the rock throughout the year; but he subsequently had reason to attribute it rather to the infiltration of water to the parts where the clay-slate and limestone rocks met. The varying quantity of this (water) through the year he now believed exerted a powerful hydrostatic energy, by which the position of the rock is slightly varied." With the light furnished by Mr. Hopkins's experiments, we may pronounce the explanation satisfactory. Armagh and its observatory stand on a hill at the junction of the mountain limestone with the clay-slate, having, as it were, one leg on the former, and the other on the latter, and both rocks probably reach downwards one or two thousand feet. When rain falls, one will absorb more water than the other; both will gain an increase of conductive power, but the one which has absorbed most water will have the greatest increase; and being thus the better conductor, will *draw a greater portion of heat from the hot nucleus below to the surface*—will become in fact temporarily hotter, and, as a consequence, *expand more than the other.* In a word, *both rocks will expand at the wet season; but the best conductor, or most absorbent rock, will expand most, and seem to tilt the hill to one side; at the dry season it will subside most, and the hill will seem to be tilted in the opposite direction.*

The fact is curious, and not less so are the results deducible from it. *First*, hills are higher at one season than another, a fact we might have supposed, but never could have ascertained by measurement. *Secondly*, they are highest, not as we would have supposed at the hottest season, but at the wettest. *Thirdly*, it is from the *different rates* of expansion of different rocks that this has been discovered; had the limestone and clay-slate expanded equably, or had Armagh Observatory stood on a hill of homogeneous rock, it would have remained unknown. *Fourthly*, though the phenomenon is in the strictest sense *terrestrial*, it is by converse with the *heavens* that it has been made known to us. A variation of probably a second, or less, in the right ascension of three or four stars, observed at different seasons, no doubt revealed the fact to the sagacious astronomer of Armagh, and even enabled him to divine its cause; which has been confirmed as the true cause, and placed in a clearer light by the experiments of Mr. Hopkins. One useful lesson may be learned from the discovery—to be careful to erect Observatories on a homogeneous foundation.

3. *Explorations under the War Department:* Explanations of a second edition of a Geological Map of Nebraska and Kansas, based upon information obtained in an expedition to the Black Hills under the command of Lieut. G. K. Warren, Top. Engr., U. S. A.; by F. V. Hayden, M.D., Geologist to the Expedition.—The geological map accompanying this paper, is prepared chiefly from the author's own observations for several years past on the Missouri river and its tributaries. For the Permian in Kansas he is mostly indebted to the labors of Maj. Hawn. A much larger surface might have been colored on the map with a good degree of confidence, but the author has preferred to let it represent the actual state of our present knowledge of the geology of that region.

The rocks of Nebraska, as far as they are at present known, are referable to the following geological systems:

I. Metamorphosed azoic rocks, including granite.
II. Lower Silurian. (Potsdam Sandstone.)
III. Devonian?
IV. Carboniferous.
V. Permian.
VI. Jurassic.
VII. Cretaceous, Upper, Middle and Lower (including Wealden?).
VIII. Tertiary.
IX. Post-pliocene or Quaternary.

The main body of the Black Hills and the Laramie range of mountains is composed of a coarse red feldspathic granite as a nucleus, surrounded by a series of Azoic stratified rocks standing vertical or nearly so, with occasional dikes or outbursts of basaltic and other trappean rocks.

The existence of the Potsdam sandstone on the eastern slope of the Rocky Mountains was discovered during Lieut. Warren's expedition to the Black Hills in the summer of 1857, and first made known by Messrs. Meek and Hayden in a paper published in the Proceedings of the Academy of Natural Sciences at Philadelphia, March, 1858. The Black Hills seem to have furnished the key to its existence in the far west,

where it is found to contain quite numerous well preserved fossils, as Lingula (L. antiqua), Trilobites, &c., similar or identical with those characterizing the same formation in Minnesota and New York. Its geographical distribution in the far west then becomes an interesting question, and the following suggestions from the paper, may call attention to that point.

"Inasmuch as we have no palæontological evidence of the existence of this formation in the Rocky Mountain range, we must depend upon the somewhat uncertain data of lithological resemblance and position, for its geographical distribution. Prof. Hall, in Stansbury's Report, often describes a bed of sandstone corresponding in its lithological characters and geological position to the Potsdam sandstone in the Black Hills. Stansbury's Island (Great Salt Lake), the summit of which is three thousand feet in height, is capped with Carboniferous limestone, which also rests upon a coarse sandstone and conglomerate. Again, north of Great Salt Lake City, the "limestone overlies a coarse sandstone or conglomerate, which almost invariably accompanies it." "In several localities, as at Promontory Point, and near Mud Island, the metamorphic strata appear to be overlaid by a coarse conglomerate or coarse sandstone, which is partially altered and assumes the character of a quartz rock." Marcou, in the third volume of Pacific R. R. Reports, page 156, speaks of a sandstone occurring near the Aztec Mountains. He says: "We traveled seven miles upon the granite, and on our right we found a cliff twelve hundred feet high. From the base to the middle we found the granite, then a band of red sandstone, (Devonian or Old Red). Above this, the beds of limestone and gray sandstone, belonging to the mountain limestone." The following day "we traveled three miles on the granite, the remainder on the Old Red Sandstone."

The diagram given, showing the order of superposition of the different rocks, would apply equally well to the similar beds in the Black Hills. Many other less evident indications along the base of the Rocky Mountains might be cited from published reports, but what has been said will be sufficient to show what we may hereafter expect with regard to its geographical distribution in the far west."

The Carboniferous rocks, so well developed at Fort Laramie, in the Black Hills, and many other localities along the eastern slope of the Rocky Mountains, have been referred by some authors to the age of the Lower Carboniferous or Mountain Limestone.

Mr. Meek was at first in some doubt in regard to which division of the Carboniferous system the fossils, which were in a bad state of preservation, belong. But after a further examination, and since he has seen in a late publication by Mr. Marcou in what association they occur in the southwest, has little hesitation in referring these rocks in the Black Hills to the upper instead of the lower Carboniferous series. The author observes:

"The Black Hills have, up to this time, afforded the most satisfactory evidence of the existence of this system in the West. It is there brought to the surface by the upheaval of the older rocks in the form of a belt or zone, five to fifteen miles in width, engirdling the principal axis of elevation. None of the organic remains already discovered, which are quite

numerous in species, are known to be positively identical with those found in the same system in the old world, but they belong to the same genera, and many of the species are so closely allied to forms characteristic of the Jura of Europe, that we cannot now hesitate to admit this system into our series. I will here repeat the palæontological evidence, which was read before the Academy in March last by Mr. Meek and myself, with such additional proof as we have been able to secure by our investigation of the undescribed fossils in the collection, up to the present time.

1st, *Pentacrinus asteriscus*, n. sp., is so nearly like the Liassic *P. scalaris*, Goldfuss, that it is with some hesitation we have regarded it as new.

2d, *Avicula* (*Monotis*) *tenuicosta*, n. sp., is very closely related to *M. substriata*, of Munster, from the Lias.

3d, *Arca* (*Cucullæa*) *inornata*, n. sp., is very similar to *C. Munsteri*, (Zeiten,) also from the Lias.

4th, *Panopæa* (*Myacites*) *subelliptica*, n. sp., is similar to the Liassic forms *M. Liasensis* and *M. Alduininus*, of Quensted.

5th, *Ammonites cordiformis*, n. sp., is of the same type as the Oolitic species *A. cordatus* (Sowerby).

6th, *Belemnites densus*, n. sp., is scarcely distinguishable from the Oolitic species *B. eccentricus*, Blainville, if, indeed, it is really distinct.

We have, also, in the collection from the Black Hills, a species of Hettangia, a genus not known to occur in the old world in formations newer than the Lias, and a Trigonia more nearly resembling Jurassic types than those of any other formation.

Although it is not yet known to occupy a large geographical area in this country, we have indications that it will be found extensively developed on the eastern slope of the Rocky Mountains, from the northern part of British America to New Mexico. That it exists toward the head waters of the Yellow Stone, around Panther and Big Horn Mountains, I cannot doubt.

In the summer of 1854, while exploring the valley of the Yellowstone, as far as the mouth of the Big Horn River, I received, from intelligent traders, masses of gypsum precisely like that characterizing the Jurassic beds in the Black Hills."

The paper closes with some remarks on the Tertiary basins of the upper Missouri. A complete "vertical section showing the order of superposition of the different beds of the Tertiary basin of White and Niobrara Rivers" is given, also a catalogue of all the organic remains hitherto described with a table showing their stratigraphical position. The number of Vertebrata given in this catalogue are sixty-three, of Mollusca five, and one Crustacean.

4. *Gold in Georgia.—Report upon the Gold Placers of a part of Lumpkin county, Georgia, and the practicability of working them by the Hydraulic Method;* by Wm. P. Blake, late Geologist and Mineralogist of the Pacific Railroad Survey in California. J. F. Trow, New York, 1858, small 4to, pp. 39, with a map.—This is a well digested statement of a subject of great commercial importance to the whole region where gold-bearing detritus is found on the Atlantic slopes of the Appalachians. Mr. Blake's familiarity with the hydraulic method as practiced in California, and which he has so clearly described in his official Report on the

Railway Survey, has fitted him in an uncommon degree to be the adviser of those who contemplate similar enterprises in the eastern gold region of the United States. He finds by exploration that gold is very generally (almost uniformly) distributed in the soil and drift on the hills, hillsides, and in the valleys and dry ravines of Lumpkin county, Ga., as in other gold regions. Water from the Chestatee river may be had in abundance, and at an elevation sufficient to wash by the use of hose all the deposits, with a probable yield of from five to twenty dollars a day for each pipe employed, with a probability of greater results. The results of assays at Dahlonega Branch Mint for twenty years show an average richness of 928 thousanths for the gold of that region. The total product to the close of 1855, nearly six and a half millions of dollars, ($6,488,932).

5. *The Tertiary Climate.*—Professor Unger of Vienna has found genuine reef-forming Corallidæ in the Tertiary strata of the Pannonian basin (southeast from Vienna) in latitude 47°, while at present the northern limit of such corals in the Red Sea and Persian Gulf is at 29°, thus furnishing a new proof of the higher temperature which prevailed in Europe at the Tertiary period.—(*Edinb. New Phil. Jour.*)

III. BOTANY AND ZOOLOGY.

1. *Obituary of Robert Brown.*—"This distinguished botanist died on Saturday last, [June 12,] at his house in Dean street, Soho, in the eighty-fifth year of his age. Though less popularly known as a man of science than many of his contemporaries, those whose studies have enabled them to appreciate the labors of Brown rank him altogether as the foremost scientific man of this century. He takes this position not so much from his extensive observations on the structure and habits of plants, as from the philosophical insight he possessed, and the power he displayed of applying the well-ascertained facts of one case to the explanation of doubtful phenomena in a large series. Till his time botany can scarcely be said to have had a scientific foundation. It consisted of a large number of ill-observed and badly-arranged facts. By the use of the microscope, and the conviction of the necessity of studying the history of the development of the plant in order to ascertain its true structure and relations, Brown changed the face of botany. He gave life and significance to that which had been dull and purposeless. His influence was felt in every direction—the microscope became a necessary instrument in the hands of the philosophical botanist, and the history of development was the basis on which all improvement in classification was carried on. This influence extended from the vegetable to the animal kingdoms. The researches of Schleiden on the vegetable cell, prompted by the observations of Brown, led to those of Schwann on the animal cell; and we may directly trace the present position of animal physiology to the wonderful influence that the researches of Brown have exerted upon the investigation of the laws of organization. Even in zoology the influence of Brown's researches may be traced in the interest attached to the history of development in all its recent systems of classification. Brown had, in fact, in the beginning of the present century, grasped the great ideas of growth and development, which are now the beacon lights of all research in biological science, whether in the plant or animal world.

"But whilst his influence was thus great, his works are not calculated to attract popular attention. They are contained in the transactions of our learned Societies, in the scientific appendices of quarto volumes of voyages and travels, or in Latin descriptions of the orders, genera, and species of plants. The interest taken in these works by his countrymen was never sufficient to secure for them republication, although a collected edition of his works, in five volumes, is well known in Germany. He was of a diffident and retiring disposition, shunning whatever partook of display, and anxious to avoid public observation. Thus it is that one of our greatest philosophers has passed away without notice, and many will have heard his name for the first time with the announcement of his decease. But for him an undying reputation remains, which must increase as long as the great science of life is studied and understood.

"Robert Brown was the son of a Scottish Episcopalian clergyman, and was born at Montrose on the 21st of December, 1773. He was first entered a student at Marischal College, Aberdeen, and afterwards studied medicine at Edinburgh, where he completed his studies in 1793. In the same year has was appointed assistant-surgeon and subaltern in a Scotch Fencible Regiment, which he accompanied to Ireland, and stayed there till the end of 1800. Having through his love of botany made the acquaintance of Sir Joseph Banks, he was through his interest appointed naturalist to Capt. Flinders's Surveying Expedition to New Holland. During this voyage the whole continent of Australia was circumnavigated, many parts of the coast were visited, and eventually the ship in which in the Expedition sailed was condemned as unseaworthy at Port Jackson in 1803. Mr. Brown remained in New Holland, visiting different parts of the colony of New South Wales and Van Diemen's Land, and eventually returned to England in 1805. Australia was then an unexplored mine of botanical wealth. Brown returned with nearly 4,000 species of plants. He was shortly after appointed Librarian to the Linnean Society. Here he quietly examined his plants, and evolved with philosophic caution and patience those views which were destined to produce so extensive and lasting an impression on science. One of his earliest papers was published in the Transactions of the Wernerian Society of Edinburgh, and was devoted to the family of plants called by him 'Asclepiadæ.' In this paper the character of mind of the author is well seen. The microscope had been used, the process of development had been watched, a new series of facts important to the laws of reproduction had been discovered, and a new order of plants established. Such was the nature of most of his future communications to the Linnean and Royal Societies. Such was the character of his great work on the plants of New Holland, which he published in the year 1810, with the title 'Prodromus Floræ Novæ Hollandiæ et Insulæ Van Diemen.' This work contained not only a description of the plants which he had himself collected in Australia, but also those collected by Sir Joseph Banks during Cook's first voyage. This book abounded in new facts and new orders. It was published as a first volume, but it was never succeeded by a second, as appeared to have been originally intended by the author. At the time this work was published, it was the practice of English botanists to arrange plants according to the artificial method of Linnæus, and Brown's 'Prodromus' was

the first English work devoted to a scientific and rational classification of plants. Although the Linnean system of classification survived some time after the publication of this work, it eventually succumbed before those principles of arrangement which were carried out in so masterly a manner by Brown, and the importance of which had been recognized by John Ray and Adanson, and even by Linnæus himself.

"In 1814 Capt. Flinders published a narrative of his voyage, and to this was attached an appendix by Brown, entitled 'General Remarks, Geographical and Systematical, on the Botany of Terra Australis.' In subsequent years several important papers appeared in the *Transactions of the Linnean Society*. Amongst others may be named, 'On the Natural Order of Plants called Proteaceæ,'—'Observations on the Natural Family of Plants called Compositæ' (vol. xii),—'An account of a New Genus of Plants called Rafflesia' (vol. xiii). In 1828 he published in a separate form 'A Brief Account of Microscopical Observations on the Particles contained in the Pollen of Plants, and on the general existence of active Molecules in Organic and Inorganic Bodies.' These movements, the full import of which is at present not understood, he was the first to point out, and draw attention to their importance. On the Continent it is the custom to allude to this phenomenon as the 'Brunonian movement.' He is the author also of the botanical appendices attached to the accounts of the voyages of Ross and Parry to the Arctic Regions, of Tuckey's expedition to the Congo, and of Oudney, Denham, and Clapperton's explorations in Central Africa. Assisted by Mr. Bennett, he has also described the rarer plants collected by Dr. Horsfield during his residence in Java.

"After the death of Dryander in 1810, Dr. Brown received the charge of the library and collections of Sir Joseph Banks, who bequeathed them to him for life. They were afterwards, by his permission, transferred to the British Museum in 1827, and he was appointed Keeper of Botany in that Institution. In 1811 he became a Fellow of the Royal Society, and has several times been elected on the Council of that body. In 1832 he received the degree of D.C.L. from the University of Oxford. In 1833 he was elected one of the eight Foreign Associates of the French Academy of Science. In 1839 the Royal Society awarded him their Copley medal for his discoveries during a series of years 'On the subject of Vegetable impregnation.' In 1849 he was elected President of the Linnean Society, a post from which he retired in 1853. During the administration of Sir Robert Peel he received a pension of 200*l*., as a recognition of his scientific merits. He also received the decoration of the highest Prussian civil order, 'Pour le Mérite,' of which his friend and survivor at the age of eighty-eight, the Baron von Humboldt, is Chancellor. Humboldt long since called him 'Botanicorum facile Princeps,' a title to which all scientific botanists readily admitted his undisputed claim.

"He died surrounded by his collections in the room which had formerly been the library of Sir Joseph Banks. In private, Dr. Brown was greatly admired by a large circle of attached friends for the singular soundness of his judgment, the simplicity of his habits, and the kindness of his disposition. He was buried on the 15th inst. at the cemetery at Kensal Green, when his funeral was attended by a large body of his scientific and personal friends."—*The* [*London*] *Athenæum*, *June*, 1858.

The obituary notice, here transferred to our pages, was written and published a few days after the decease of the great botanist of our age. We know not whether we may in time expect, from the same competent hand a fuller account of Mr. Brown's labors and writings, and a critical estimate of the influence they have exerted upon the progress of scientific botany in the nineteenth century. Such an exposition should be attempted, both as a fitting tribute to great master's memory, and because few even of the cultivators of science, besides the leading botanists of the day, are well aware of the nature and extent of this influence. It has reached the generality even of botanists only by indirect channels, after permeating—all too slowly and imperfectly—the minds of the principal systematic writers and teachers of the last half century. While every student of general botany daily uses the works of DeCandolle, and has some tolerably clear idea of his indebtedness to Linnæus and to Jussieu; while these and some inferior names are familiar to most educated persons, how few even of his own countrymen knew anything of a botanist, surviving to the present year, who was second only to the most illustrious of these in the extent and depth of his knowledge, and second to none in sagacity. This has been owing, "partly to the length of time that has elapsed since his great discoveries were made; partly to the quiet and unostentatious manner in which they were announced; partly to the brevity of his style, and the comparatively small bulk of his published works, and most of all to his singularly retiring and unobtrusive disposition;"* and partly, we would add, to some characteristic peculiarities in his mode of communicating his results, which none of these specifications, nor all of them, fully describe. How thoroughly he has been appreciated, however, in his life time, in the ranks of pure science is evident from the deference with which his name is pronounced by the *savans* of every country, by the title with which Humboldt long ago saluted him, and by the fact "that his name stands at the head of the list of honorary fellows of more scientific academies than that of any other individual, not even excepting Humboldt."* How profoundly he has been admired and venerated by those who enjoyed the enviable advantage of his acquaintance and his friendship, this is not the place to say.

Whoever undertakes to present a summary of his investigations and a just estimate of their importance, will have to write the history of botany, in all its departments, for the last fifty years, and to point out,—perhaps in some sententious note, in a short paper whose title made no proclamation of the high questions it incidentally discussed,—the germ, if not the succinct development, of each discovery or philosophical deduction which has stood the test of time and helped to make modern botany what it is; and will commend his style as a model of compactness and precision. Whoever portrays the lineaments of so marked a character as that of Brown will exhibit, among its distinctive features, his unrivalled sagacity, his lively and pervading sense of justice, his perfect impartiality and truthfulness, his profoundly conscientious accuracy; and also his extreme caution, and an excessive retinence in strong contrast with the desire of most discoverers to communicate their knowledge to the world. Perhaps no naturalist has ever taught so much in writing so

* Gardener's Chronicle, June 19.

little, or made so few statements that need to be corrected or even modified; and in respect to none can there be a stronger regret that he did not publish more. A. G.

2. *Journal of the Proceedings of the Linnæan Society*, No. 8, concluding Vol. II, was promptly issued in May. The botanical portion contains, *Botanical Report on the North Australian Expedition under the command of A. C. Gregory, Esq.;* by Dr. Ferdinand Müller, Botanist of the Expedition. This is concluded from the last number; it ends with some tables showing the range northward of extratropical Australian species; and with an index of the genera observed, with an approximate determination of the number of species of each collected.

Præcursores ad Floram Indicam; by Drs. Hooker and Thomson.—In the present number the *Caprifoliaceæ* are elaborated. The genera of *Lonicereæ* are *Loniceria*, *Leycesteria* (hardly distinct from the former genus), *Triosteum* (a North American species with one Himalayan species), *Abelia* (a Chinese and Japanese type), and *Dichilanthe* of Thwaites, from Ceylon. Of the *Sambuceæ*, there are the two genera, *Viburnum* and *Sambucus*. A preliminary note explains the structure of the ovule in the order; it is a nucleus with the integuments nearly undeveloped. "Besides the many well-known points of close affinity between *Caprifoliaceæ* and *Rubiaceæ*, an examination of the Indian plants of the former order enables us to add one which has generally been supposed to present a good distinguishing character between them, namely, the large stipules present in two genuine specimens of *Lonicera* itself." We add that such stipules are evident in several species of *Viburnum*.

Extract of a letter from Mr. George Barter; the botanist of the new expedition now exploring the Niger or Quorra.

On the question whether Linnæus, in a spirit of ill-will, altered the spelling of the name of the genus Buffonia; by Prof. Fée, of Strasburg.

Note on the preceding communication; by John J. Bennett, the Secretary of the Linnæan Society, giving the result of an examination of the letters addressed by Sauvages (the real founder of the genus) to Linnæus. The result arrived at is that the charge is unfounded. Because the name, mis-spelt *Bufonia*, was published by Linnæus in the year 1747; "and it was not until 1749 that the offence, which it has been supposed to be intended to avenge, was given to Linnæus and all other 'methodists,' in the preface to Buffon's great work, commenced in that year." The converse question is not raised whether the misspelling of the name, however it happened, may not have been an exciting cause of Buffon's attack. A good index of species is appended to the volume. A. G.

3. *Flora of Australia.*—The British Government having made a handsome appropriation for the preparation of a general Flora of Australia, it is understood that Mr. Bentham will undertake this formidable work. It could not fall into more competent hands. Now that the government of India is vested in the crown, and the enlightened statesman who, when Colonial Secretary, procured this appropriation to be made is likely to be placed at the head of the Indian government, we shall confidently expect to hear of a similar grant, by which aid alone can one of the most important works of the age, viz. *Flora Indica* of Drs. Hooker and Thomson, be continued and completed. A. G.

4. *Life Beneath the Waters, or, The Aquarium in America;* by A. M. EDWARDS, member of the N. Y. Lyceum of Natural History. New York, H. Bailliere, 1858.—Notwithstanding the great interest which has been felt in this country for the last two years in the beautiful water-gardens which form the subject of this book, the public have as yet been entirely dependent for a knowledge of their construction and management upon the various English works relating to them, which have appeared in rapid succession since the year 1850, when they were first invented in that country. The natural history in these works answers admirably for students on the transatlantic shores, but is of little use in our country, where the aquatic animals, both fresh-water and marine, are mostly very different from those of Europe.

The announcement of the title of the work, "The Aquarium in *America*," was hailed with pleasure by the many lovers of nature on this side of the Atlantic,—notwithstanding the implied assertion that it was newly introduced here, while in fact, these self supporting aqua-vivaria were used here before their invention in Europe. Still nothing had been published in regard to the subject; and the want of a work which would inform those interested how to establish and stock their tanks, and to learn the names and characteristics of the animals and plants placed in them, was felt by all. This want, however, the work before us fails to supply. Notwithstanding its patriotic title, it is still a *British* book, consisting in great part of ill selected matter from Gosse, Humphrey, Hibberd, and other British authors. Were this openly avowed, no harm would be done, for the reader would then understand that the zoology of the work applied mostly to Great Britain; but as it is, unless well versed in the science, he is led to suppose that a large number of the species belonging to that country are commonly found on our shores, while in fact they do not exist here at all. On page 23, for instance, our author in describing the contents of his tank, mentions *Actinia mesembryanthemum*, *A. fragacea*, *A. tigrina*, and *A. gemmacea;* but omits to mention that these are all British species. It is somewhat surprising that Mr. Edwards should have had to import Actiniæ from Europe, when we have so many equally beautiful species living among our own rocks and islands; but this, as well as the whole tenor of the work, abundantly shows that the author has but a very slight and imperfect acquaintance with our marine zoology. The list of sea animals is very meagre; thus out of some 600 species known to inhabit our shores, only about thirty or forty are mentioned, and these by no means the most beautiful and interesting, nor the best adapted for an existence imprisoned in the aquarium.

Among the animals attributed to America, but which do not really exist here, the following may be mentioned: The *Triton* figured on plate 6 is a British species. On page 77 *Lymnæa fragilis* is said to be an inhabitant of New York; it is also British. Neither of the *Scorpænæ* mentioned on page 116 are found on our coast; nor is the *Fistularia tabacaria*, incorrectly classed with the "hideous pipe-fishes" *Syngnathus*, which latter are among the most beautiful and long lived fishes that can be placed in an aquarium. On page 117, our common fresh water sucker "*Catostomus communis*" is said to be a marine fish! Our malacologists will be surprised to learn, on page 77, that the genus *Physa* is represented in New

York by eleven species! Among other remarkable statements we notice the following. On page 133, a zoophyte is said to consist like a "human creature," of "flesh, blood, and bone." The means by which certain zoophagous mollusks perforate the shells of bivalves is said to be "yet unknown." The story told on page 143, of the terrible Actinia some feet in diameter by which an officer of the British navy was seized, would apply with greater probability to a large *Octopus*.

These few examples are enough to enable the reader to determine how much reliance is to be placed upon the scientific accuracy of the publication before us. Yet on page 46 the author very ingeniously suggests to the collector who has returned home laden with the spoils of the river-bank or sea-beach, to "take this or any other book that treats of the subject, and see if you can find out the names of your plants and animals." We advise the reader by all means to try the 'other book.'

The work abounds in typographical (?) errors and misspelt scientific names and terms. We write *typographical* with a query, being in doubt whether errors occurring simultaneously in the plates and text can properly be charged to the printer. Yet the list of Errata contains only three or four attempts at correction, which are not always successful, as "for *T. tabbacaria* read *F. tabbacaria*," and "for *cyprynis* read *cyprynus*." And such terms as "tentaculae," "Crustaceae," "planorbi," etc., which are constantly recurring, certainly do not speak well for the erudition of the author.

The *plates* are remarkable neither for accuracy nor artistic excellence. The figures of marine animals, with the exception of those copied without acknowledgment from British works, are mere caricatures of the original. In some of the Crustacea, for instance, opposite feet are represented as differing in the number of joints.

The work, nevertheless, contains many novel and valuable suggestions concerning the management of the aquarium, about which the author's experience as a dealer enables him to give much reliable information.

W. S.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *The Atlantic Cable.*—While all hoped earnestly for the successful issue of the last telegraphic expedition which left Queenstown, England, July 17, for mid ocean, we believe there were few whose fears of a third failure were not greater than their hopes of success. When, therefore, about noon of August 5th, the news of the safe arrival of the Niagara and Gorgon at Trinity Bay, with the cable unbroken, was flashed over the length and breadth of the land, there was at first, almost universal skepticism as to the authenticity of the news. This gave way, however, in a few hours before the accumulating evidence, and a wild gush of joy broke out from every quarter, such as no event in modern history has ever occasioned.

The great fact that the cable is laid without accident, and that its insulation and transmitting power are reported perfect, render the question of plateau or no plateau, discussed on pp. 157 and 219 of this volume of secondary importance to the public; and yet as a geographical and geological problem, it is still one of great interest. We may be permit-

ted to say that while we believe, on what seem to us ample geological grounds, in the pretty uniform and rather moderate depth of that portion of the Atlantic where the cable now rests, it has never appeared to be a point of much practical moment whether the depth of water in which the cable was to be laid was 1000, 2000, or 3000 fathoms. In any case it was very sure to find bottom and rest there; and the distance across is no greater at the greater depth. The discussions of Professor Trowbridge afford valuable suggestions with regard to all deep sea soundings, and we trust that his method when perfected may be the means of giving us reliable results respecting the whole ocean.

In the absence of any official documents, we quote from the daily journals some facts relating to this great event, drawn from the private journal of CYRUS W. FIELD, Esq., to whose dauntless energy, skill, and hearty faith in a successful issue, the world will ever be eager to award the highest praise, since to him more than to any other person belongs, beyond doubt, the credit of conceiving and carrying through this great enterprise.

Saturday, July 17, 1858. The telegraphic fleet sailed from Queenstown, Ireland, as follows: the Valorous and Gorgon at 11 A. M.; the Niagara at 7½ P. M., and the Agamemnon a few hours later. All the steamers were to use as little coal as possible in getting to the place of rendezvous.

Friday, July 23. The Niagara arrived at the rendezvous, latitude 52° 5′, longitude 32° 40′ at 8.30 P. M., the Valorous followed at 4 A. M. of July 25, the Gorgon at 5 P. M. July 27, and the Agamemnon at 5 P. M. of July 28. The weather had been cloudy and squally until the 21st, but appears on the whole not to have been unfavorable.

Thursday, July 29. Latitude 52° 59′, longitude 32° 27′ W., the telegraphic fleet all in sight, with a smooth sea, cloudy sky, and a light wind from the S.E. to S. At 1 P. M. of this day the "splice" was successfully made between the two ends of the cable, and electrical signals passed perfectly through the whole length on board both ships. Depth of water 1550 fathoms. The distance from the entrance of Valentia harbor was eight hundred and thirteen nautical miles; to the entrance of Trinity Bay, N. F., eighteen hundred and twenty-two nautical miles, and from there sixty miles to the telegraph house at the head of the Bay of Bulls, equal in all to eight hundred and eighty-two nautical miles. The Niagara had sixty-nine miles farther to run than the Agamemnon. Each ship had on board about eleven hundred nautical miles of cable. The following table presents a condensed view of the Niagara's voyage:

Date.	Lat. N.	Long. W.	Dist. sailed in last 24 hours.	Miles and fathoms of cable paid out.	Excess per cent.	Depth of water in fathoms.
July 30, Friday,	51° 50′	34° 49′	89	131*m.*	48	1550—1985
" 31, Saturday,	51° 50′	38° 28′	137	159*m.* 853*f.*	13	
Aug. 1, Sunday,	50° 32′	41° 55′	145	164*m.* 683*f.*	14	1950—2424
" 2, Monday,	49° 52′	45° 37′	154	177*m.* 150*f.*	15	1600—2385
" 3, Tuesday,	49° 17′	49° 23′	147	161*m.* 763*f.*	10	1742(?)—1827
" 4, Wedn'y,	48° 17′	52° 43′	146	154*m.* 360*f.*	6	200
" 5, Thursday,	Niagara anchored.		64	66*m.* 382*f.*	4	

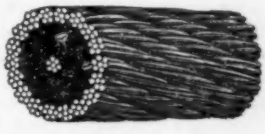
It will be observed that the distances run during the five full days were remarkably uniform, 149 miles per day, and the excess of cable paid out was about 15 per cent more than the ship's record. Twice during the

progress of the ship, from some unexplained cause, signals failed to pass between them, viz: at 7½ P. M. July 29, for an hour, and August 2, from 12h 38m A. M. to 5.40 A. M. But during all the remainder of the time signals were constantly received; and at the last, the Agamemnon, August 5, 2.45 A. M., signalized the Niagara that they had paid out 1010 miles of cable. The cable was landed at Valentia Bay on Thursday morning, August 5, at 5h 15m; and at 6 A. M. the shore end was carried into the telegraph house, and a strong current of electricity received through the whole cable from the other side of the Atlantic.

On the 17th of August the Queen of Great Britain sent a congratulatory message to the President of the United States, expressing in courtly terms her joy in the completion of this great international bond, to which President Buchanan responded in the same spirit. It has been suggested elsewhere that the Boston fire-bells, which are now rung by electricity, should be placed in communication with London and rung by the current from the company's office there.*

In the absence of any accurate scientific report of the details of the electrical arrangements, we are able at present to state only a few facts, most of which are probably already familiar to our readers.

The cable is only about six-tenths of an inch in diameter outside of the encasing wires. The figure annexed is a correct view of the exterior form and cross section of the cable. The electrical conductor is formed of seven No. 22 copper wires, the centre wire being straight, while its six surrounding wires form a spiral about it. The insulation is of refined gutta percha, laid on by machinery in three distinct coatings the more perfectly to insure insulation. Finally, seventeen strands of iron wire, No. 20, composed each of seven separate wires, laid up like the electrical conductor, encase the whole into a strong but very flexible rope, as easily handled as a rope of hemp. All the mechanical work and materials used in the preparation of the cable have been of the best description. The whole length of separate wires in this cable amounts to 332,500 miles, or about fourteen times the earth's circumference. The weight of the cable is almost exactly one ton (2000 lbs.) to the mile, and it bears a direct minimum strain of four tons, and much more has been put on it without fracture.



The magneto-electrical current designed to be employed is derived from a powerful combination of inducing coils and soft iron magnets. The cable is regarded as a Leyden jar inductively charged, and Mr. Whitehouse, the electrician of the company, states that by alternating impulses of positive and negative electricity, transmitted in rapid succession to the copper conductor, the evil effects of the reflex induced current in the iron wire cover is entirely overcome. We look with much interest for the memoir, which we suppose of course will be published by the company, giving the physical details, and the constants established by this elaborate research. It will also be very interesting to see on record an official description of the manufacture and paying out of the cable, with full plates, and a statement of the chief causes of delay and embarrassment, and their cure. But the

* Boston Transcript, August 13, 1858.

portion most interesting to science will be the electrical history of this great enterprise, the details of which have hitherto been only partially revealed, and that not in a scientific form. The only official account of the undertaking which we have seen is a pamphlet issued in July, 1857, by the company in London, entitled "The Atlantic Telegraph, a history of preliminary experimental proceedings, and a descriptive account of the present state and prospects of the undertaking." This pamphlet contains some novel and very interesting statements, but they are wanting in that accuracy and fullness of detail indispensable to a scientific statement, and the results are generally given only in rather vague terms.

2. *Notes of a visit to the "Mud Volcanoes" in the Colorado Desert, in the month of July*, 1857; by JOHN A. VEATCH, M.D., (Proc. California Acad. Nat. Sci., p. 104, 1857).—Among the numerous objects in California inviting the investigation of the scientific and the attention of the curious observer, none are more conspicuous than the "Salses" or "Mud Volcanoes" of the Colorado Desert. Hidden amidst the burning sands of a frightful waste, few persons have had the temerity to encounter the labor and risk of visiting them. Even the Indians, inhabiting the border of this Western Sahara, do not willingly venture so far into its midst, unless it be during the annual rains. At any other period, to miss one of the few springs of brackish water, or to find the place occupied by drifting sands—a not unusual occurrence—would entail the certainty of the horrors of thirst, if not loss of life. From personal experience I cannot blame the repugnance of the natives to visit a district, which, in addition to its physical repulsiveness, they suppose to be the abode of dark and malignant spirits.

The striking peculiarities of this wild region are, however, too striking to remain long unsubjected to thorough exploration. The entire desert is supposed to have been the bed of a great brackish or fresh-water lake, and is said to lay many feet below the level of the ocean. The part I lately visited showed deep lacustrine deposits, inclosing, in myriads, the conchological records of the former sea.

It was the month of July of the present year that I had occasion, in the progress of a mineralogical excursion to visit one of the above named salses. It is situated about one hundred and fifty miles from San Diego, and sixty miles in a north-easterly direction from the Indian village of San Felipe—the nearest inhabited habitable place. The exact locality, as reported by the U. S. Surveyors, is Township 11 South; range 13 East, San Bernardino meridian. The distance from San Felipe is as above given in an air line; but by any practicable route it is, at least, thirty miles farther, owing to the necessity of making a turn to the south, to find the only water on the route.

At the above named village, at the trading post of Messrs. Smith and Brill, we—myself and son—made preparation for our desert excursion, by procuring fresh horses and a guide, and obtaining provisions, and gourds and leathern bottles for carrying water. Our guide, José Serano, who was one of the Captains of his village, spoke Spanish, and was the only one of his people who had ever been actually at the spot we wished to visit. The weather was intensely hot, and the guide advised starting late in the afternoon, so as to have the advantage of a night's journey, and

thereby reach the watering-place early the next day,—before the heat became oppressive. The following I extract from my notes:

"Left San Felipe at 4 o'clock, P. M., July 17. Crossed the sharp Porphyritic mountain ridge separating San Felipe valley from the desert. San Felipe Creek cuts through the ridge here and runs off in a narrow cañon towards the desert. It is a bold, running stream, but never emerges from the cañon in summer, being literally drank up by the first breath of the thirsty desert wind. The bed of the stream is not practicable for horses, so we climbed the mountain, along an Indian pathway, and from the crest—about 1000 feet above the valley—had an extensive view of the desert, shading away into gloomy indistinctness and blending with the dull clouds that skirted the horizon toward the east. To the right and left, as far as the eye could reach, the mountain chain presented a series of fantastic and rugged serratures well in keeping with the sombre area of barren desolation it hedged in. A few stunted mesquit trees, a dwarf magey and a pretty fair representation of the Cacteæ, constituted the flora of the mountain. Descending the eastern slope at a rather sharp grade, we re-entered the San Felipe cañon. We received now and again puffs of hot wind, giving us a foretaste of the furnace-temperature of the broad, herbless plain below. The cañon sloped off rapidly, but with great regularity, expanding into a valley two or three miles wide and finally losing itself in the desert ten miles beyond. The soil—if the term be applicable—consisted of detrital matter and debris of the mountain rocks. A species of Catalpa, with slender, pendulous pods, grew in depressions marking the beds of winter torrents, and clusters of a tall shrub covered with strong sharp prickles from the root to the extremities of the branches, gave warning not to approach them too closely. Succulent and arborescent Opuntias occurred in clumps and patches; and the Echinocactus, with its rigid fish-hook spines, lay often half covered in sand, and our horses frequently started suddenly to one side to avoid them. The columnar form of a huge Cereus crowning some rocky eminences presented, often, a peculiar and picturesque appearance. Night overtook us in the valley, and our progress was much impeded by the Opuntias constantly pricking the horses, rendering them restless and fretful. The road grew worse and worse every mile, and about 11 o'clock a dense forest of bristling vegetation completely blocked the way. In attempting to force the barrier, my horse became furious and commenced plunging, and I had to choose between throwing myself off into the spring moss or suffer the horse to do it for me. I chose the first, and in attempting to hold the infuriated animal, was dragged and shoved alternately amongst Opuntias higher than my head, until my clothes were literally pinned to the flesh from head to foot by the barbed needle-like prickles. The horse fared no better, but I felt no great consolation on that score. José, with his *reata* came timely to the rescue, and the horse was secured just as the bridle reins broke in my hand and I came near experiencing the additional unpleasant mishap of being left horseless. Farther progress for the night was out of the question. The horse had freed himself from the saddle and riding gear, and was so covered with spines rankling in his skin, that to replace them was impossible; and even could the horse have borne the saddle the rider could not have borne the seat. So tying up in the most favorable spot that offered, a

light was struck and the residue of the night spent in extracting prickles from the flesh of man and horse.

"*July* 18.—At early dawn started again and had the good fortune to thread our way through the horrid grove without further mishap. A smooth surface of baked clay, in which not even a Cactus could root itself, gave place to the disintegrated mountain deposit, over which we passed at a sweeping trot. A beautiful specimen of selenite was picked up here, and water worn pebbles occasionally occurred. Two hours' ride brought us on to an enormous clay deposit, with fragments of thin bivalve shells—probably the margin of the ancient lake. The soil became gradually more sandy and the variety and number of shells greatly increased. Finally the entire deposit consisted of fine sand and clay, with minute univalve shells in astonishing quantities. Hillocks formed by drifting sand accumulating around clumps of mesquit bushes, leaving only the branches exposed, gave some variety to the surface of the plain. A few black Tabanis (horse-flies) came buzzing about the horses, and a large spotted-winged Libellula flitted by us. The presence of these insects was the more remarkable as the distance to water was not less than ten miles. Their appearance, insignificant as were the little creatures, was cheering and relieved the sullen sadness always produced by the total absence of animated beings. At 10½ A. M. we reached water, after thirteen and a half hours' riding; horses much fatigued, hungry and half mad with thirst; water brackish and warm, proceeding from a large fountain which rises up in the bed of a ravine, boiling and bubbling with the constant evolution of gas—probably carbonic acid. It runs off northeast in a stream yielding about 500 gallons per minute; but within half a mile it is lost in the porous soil, and there is no further trace of it. The ravine in which it rises comes from the southwest, and is probably a continuation of Cariso Creek. It here forms a little valley some hundred yards broad, covered with bushes and coarse grass—among which the stream meanders from side to side of the valley. The depression below the common level of the desert is about forty feet. I will take occasion to mention here that appearances presented by the bottoms of ravines, wherever I observed them, indicated that water might anywhere be found at a depth not exceeding forty feet. A small grove of mesquit trees, (Prosopus glandulosa) with a heavy crop of dry legumes, stood on the brink of the ravine. The fruit formed a welcome repast for the horses, and the slight shade of the scattering boughs afforded us some protection against the sun-rays; with blankets spread over them a tolerable shade was produced, but afforded no barrier to the parching blasts of wind that came like the breath of an oven. I was driven to the water, where, with the tall rushes bent into a kind of bower and sitting up to the neck in the stream, I voted myself the presiding genius of the place, and half dozing, rested comfortably for an hour.

"At 5½ o'clock, P. M., started again, hoping to reach the volcanoes by midnight. To lighten the burden of the animals, all our provisions, blankets and extra wearing apparel, were left behind, taking no weight save our arms and supply of water. Two black butes, betwixt which our course lay, in a north-easterly direction, served us as guides. Within two miles, we came to a small stream of water, rising in a ravine but not

sunk more than fifteen feet below the plain. It ran toward the north a very little way, and was lost by evaporation and absorption. Beyond this, we crossed a superficial clay ridge, strewn with pebbles and fragments of obsidian; near sun-down entered a sandy district, the horses sinking fetlock deep each step; after dark the butes being no longer visible, kept our course by the stars. By-and-by the atmosphere became hazy, and only occasional glimpses could be had of the stars. Wandering from our course we got into loose, drifting sands, thrown by the winds into ridges and hillocks, through which the animals plunged and struggled, and finally we had to dismount and lead them. José declared himself lost, and refused to go any farther till morning. There being no means of securing the horses, in case of a halt, we continued to toil on, and fortunately got off the sand banks in a little while. Soon, a few sage bushes were encountered, and selecting the stoutest, the animals were fastened to await the coming of to-morrow. In attempting to make our beds, the burning temperature of the earth required the interposition of saddle-blankets and leathern covers of the saddles, and still it seemed like submitting our limbs to the process of baking. The restlessness of the horses kept us in constant fear lest they might break the insecure fastenings and leave us in a rather unenviable predicament. It is useless to say the night was not passed in refreshing slumbers, and the dawn was never more welcome.

"*July* 19.—At daylight it was found that we had wandered last night too far to the north, and had to turn to the south and east. The white clouds of steam, shooting upward from the Salse, soon became apparent at the distance of ten miles. At sunrise the steam-jets presented an imposing and singular appearance; the cones from which they issued were distinctly visible, and the dull roar of the subterranean tumult could occasionally be heard. The black butes that served as landmarks yesterday lay on either hand—that to the left less distant. It had the appearance of a mass of lava heaped into a rough and fantastically irregular hill, crowned with sharp pinnacles and rude arches, as if the whole had been hardened suddenly while in a state of most violent agitation from boiling. The more distant one to the right seemed a black, compact mass, with a glittering smooth surface, common to the granite and gnisease rocks bordering the desert. If volcanic, the character was not so apparent as in that to the left.

"A little after 6 P. M. reached a point as near the Salse as was deemed prudent on horseback. The ground had become soft and muddy, and the sulphurous scents and strange sounds frightened the horses. Giving them in charge of José Serano, we proceeded on foot about a quarter of a mile to the scene of action. The scene presenting itself is difficult of description. The effect can only be known by one who has heard the wild rush of steam, the rude sounds of the mud explosions, and the dull murmur of the boiling cauldrons of slime. The space occupied by the Salse is a parallelogram, five hundred yards long and three hundred and fifty broad—a table of hardened bluish clay, a little elevated above the surrounding plain. The adjacent ground is low and muddy, and during the rains is entirely covered with water. There is a gentle slope towards the north and east, the mud and water of the Salse running off slowly

in that direction, where a lake of salt water exists in the rainy season, but presenting now a vast sheet of crystalline chlorid of sodium. Into this lake the arm of the Colorado, known as New river, discharges itself. The lake, having no outlet, would probably soon regain its ancient area if the channel of New river afforded a regular and more generous supply of water.

"The steam-jets of the Salse issue from conical mounds of mud varying from three to fifteen feet in height, the sides presenting various angles, some being sharp and slender cones, others dome-shaped mounds that seem to have spread and flattened out with their own weight, upon the discontinuance of the action that formed them. Out of some of the cones the steam rushes in a continuous stream, with a roaring or whizzing sound, as the orifices vary in diameter or the jets differ in velocity. In others the action is intermittent, and each recurring rush of steam is accompanied by a discharge of a shower of hot mud, masses of which are thrown sometimes to the height of a hundred feet. These discharges take place every few minutes from some of the mounds, while others seem to have been quiet for weeks or months. During our short stay we had specimens of the rapidity with which a sharp, conical mound could be built up and again tumbled down. In one place a stream of hot water was thrown up from fifteen to thirty feet, falling in a copious shower on every side, forming a circle within which one might stand without danger from the scalding drops, unless the wind chanced to drive them from their regular course. It issued from a superficial mound out of an opening about six inches in diameter; but the column of steam and water, immediately upon issuing, expanded to a much greater size. The orifice was lined with an incrustation of carbonate of lime, and around it, and particularly on the southeast side, stood a miniature grove of slender stalagmitic arborescent concretions of the same substance. They were from half an inch to one and a half inches in diameter, and from four to eight inches in height. Many of them were branched and the tips colored red, contrasting beautifully with the marble-whiteness of the trunk, and resembling much a coral grove. Some were hollow, and delicate jets of steam issued from their summits, and this seemed to explain the mode of their formation. Some were not hollow throughout, being closed at the summit, but when detached from their base, a small orifice in the centre suffered hot steam to pass, and some degree of caution was required to remove them without scalded fingers. To approach the spot was a feat of some difficulty, surrounded as it was by a magic circle of hot rain. I retreated, scalded, from the only attempt I dared to make; but my son, more adventurous or more attracted by the beauty of the specimens, succeeded in bringing away several. The falling water ran off into a pool a foot deep, but what became of it was not apparent, as it had no seeming outlet. I brought away a bottle of it for examination. It was transparent, but had an intensely bitter and saline taste. A little beyond on either hand, are two huge cauldron-like basins, sunk five or six feet below the general level, and near a hundred feet in diameter. Within these cauldrons a bluish argillaceous paste is continually boiling with a dull murmur, emitting copious sulphurous vapors, and huge bubbles, bursting, throw masses of mud to the height of several feet. These kettles sometimes boil over,

and the matter runs off in a slimy stream toward the salt lake. This seems to have been the case recently, as we encountered the track of one of these streams, not yet dry, a mile from the Salse.

"The volcanic action was far more violent at some former period than at present, as is proved by the erupted bute, above named, as well as by fragments of pumice scattered over the plain.

"Our visit lasted only an hour and a quarter. The sun was already scorching hot, and our supply of water could not last, with the most rigid economy, more than three hours longer. The watering place, left yesterday, was not less than twenty miles distant. A spring was marked by the United States surveyors, only four or five miles to the north, but as no land-marks were known by which it might be found, it would have been rash to waste time in seeking it. The tempting objects in the vicinity, which would require many days for examination, could only be greeted with a farewell glance, and our horses' heads were turned towards the water. Leaving the sand-hills, that gave us so much trouble, to the right, our course lay southwest.

"We soon had reason to congratulate ourselves upon being clear of the drifting sands. The winds increasing as the day advanced, whirled the dust into a black cloud, through which José declared it would be impossible to travel. It would certainly have been exceedingly unpleasant, to say the least. The season of the rains was due—the Sonora rains prevailing here—and showers were observed at a great distance, but none approached us.

"For the first three or four miles after leaving the Salse, the plain presented a smooth surface of sand and bluish clay, baked and fissured, and strewn sparingly with volcanic cinders and obsidian fragments. Round holes marked the escape of gas when the ground was softened by water. Soon the plain became cut up with ravines three or four feet in depth, which José said were the arms of 'New river,' which branched out before entering the salt lake. The remains of a most luxuriant vegetation, now dead and dry, proved the place to be a desert only for want of water. The suddenness and rankness of grass and weed growth where the New river broke away from the Colorado, some years since, and irrigated the desert, is remembered by many who witnessed the magic-like transition from barrenness to fertility. An intervening sandy district confused our course—loose and drifting but not deep—and fortunately no sand-storm was gotten up for our benefit while passing it.

"It was now near noon; the wind blew a gale, but seemed only to add, by its scorching dryness, to the raging solar heat. Our water bottles were exhausted, and the distance betwixt us and the watering place was yet ten or twelve miles. Two hours' deprivation of water is certainly no great inconvenience under ordinary circumstances, but on the desert can only be appreciated by one who has felt it. About 2 o'clock, P. M., the green bushes and cheerful rippling of water greeted us, and men and horses plunged in and blessed the fountain in the desert.

"The tired condition of the animals made it imprudent to leave our present position until they were somewhat recruited, so arrangements were made for a shelter from the sun. A black cloud that had been slowly

heaving up for some hours from the west, at last met the sun's track and brought its friendly shadow to our relief. After a refreshing nap of two hours an attempt was made at getting up a breakfast—we had eaten nothing during the day—but all appetite was gone, and nothing craved but continued drafts of water. José, however, was a bright exception, and had certainly lost nothing of his gastronomic powers, but merrily devoured the meal prepared for the three.

"As night closed in two or three black bats came forth from their hiding places, and a solitary goat-sucker flitted around in silence. No other animals appeared, save a lizard, whose movements were too quick for us to capture him, and three Coleopterous insects, which, less agile than their neighbor, fell a sacrifice to the interests of science.

"On the morrow—Monday, the 20th—it was still thought imprudent to leave until evening, so as to make the most of the journey to San Felipe during the night and early the following day. The forenoon was therefore spent in collecting a few shells from the soil, one of which, the Physa humerosa, was still found inhabiting the water of the spring. Two species of fishes were observed about an inch in length, one slender and of a whitish color, the other broad in proportion to length, and dark colored, looking like a small perch. Our guide states that this secluded spot was his early home. He was born here, and the tribe he now rules over here had their lodges, and lived in abundance on the maize, melons and frijoles that he describes as growing with a luxuriousness unknown to any place away from the so-called desert. A succession of rainless summers drove them away, and they have not since returned. They planted with the early rains, say in July or August.

"At 4 P. M. bid adieu to our camp and set out for San Felipe. About midnight we arrived on the margin of the Cactus thicket—the scenes of my former mishap.

"*July* 21.—At daylight again on the move, and startled a vagrant coyote, the only one ever seen in our route. A trail of a flock of mountain sheep was observed, and the head of one, probably killed by Indian hunters, lay by the wayside. At 10½ A. M. the welcome sight of San Felipe cheered us from the heights above it, and a half hour found us safe under the hospitable roof of Messrs. Smith & Brill."

Thus ended a hurried trip to a most interesting spot in the midst of a no less interesting district. The shells obtained were submitted to Dr. Trask, and were found to consist of two species of Amnicola (A. protea and A. longinqua, Gould) and the Physa (P. humerosa, Gould) before named. A large bivalve was observed, but so thin and fragile that the specimens broke to small pieces for the want of safe means of transporting them.

The water from the volcano has the specific gravity of 1·075, and holds in solution free *boracic acid*, with *borates* and a large quantity of chlorid of sodium, and other salts. These matters would indicate the true volcanic origin of the Salse, and but little doubt rests on my mind of its being so. The evidence of former volcanic action in the neighborhood, and the testimony of the boracic acid, establish its true character. The acid and its compounds exist only in small quantities, but sufficient to be unequivocally determined. Similar Salses exist some thirty or forty miles farther south. One made its appearance during the earthquake of November 29,

1852, a few miles below the line of the State. Two others exist in the same district, as I was informed by a person who professed to have visited them. One is represented as a single jet of steam and water from an opening a yard in diameter, situated in a plain of hardened clay. The other consists of several pools of warm water, through which hot gas is continually escaping. Another is again spoken of in the adjacent mountain, partaking of the true volcanic character, emitting fire and smoke. I hope some one will soon have occasion to examine these and other interesting localities at a season when it will be practicable to pass a few days on the desert without danger of perishing from thirst.

The real character of this desert has not been generally understood. In its present condition it is truly a desert. But only a portion, however, of its immense area is condemned to irretrievable barrenness—viz: the part covered with drifting sands. The greater part, from the constituents of its soil, must be fertile in the extreme, and only wanting moisture to produce a wilderness of vegetation. This is proven in the case of New river, while it continues to run. This arm of the Colorado might be made permanent, but a far more convenient supply could be furnished by Artesian wells, or better still, by wind-mills raising water from common wells, as is now so successfully practiced throughout the fertile valley of San José. As stated before, there is every reason to believe water can be had anywhere at a depth not exceeding thirty or forty feet.

As the great Southern Railway must pass through this district, it is interesting to know that the now dreaded desert can easily be changed into the happy homes of a thriving people. Repulsive as are at present the features of the country, the presence of a railway will convert it into the garden of the Pacific slope, and it is destined to become the cotton and sugar growing district for Arizona, Utah, California and Oregon.

Since writing the above I have had the pleasure of seeing a letter from Dr. Newberry, Geologist of the Colorado Exploring Expedition, fitted out by the United States government, to Dr. W. O. Ayers, of San Francisco, from which I am kindly permitted to make an extract. Speaking of the desert, he says, "I find it not a bad country—having, most of it, a better soil than the mountain district west of it. If water could be supplied regularly to the New river country it would be a perfect garden."

3. *Gutta Percha of Surinam.*—Professor Bleckrod of the Delft Academy, has recently given a notice of the gutta percha of Surinam. Although gutta percha has been known in Europe for a dozen years, and has now come into general use, yet much still remains to be done regarding it, both as respects its uses and its sources. The Professor states that Dutch Guiana can supply gutta percha. This is of importance, when we consider the value of the article, and the probable exhaustion of it in the countries from which it is now supplied. The Dutch Government took measures to transplant the *Isonandra Gutta* and cultivate it in Guiana; but they have lately discovered in that country a species of Sapota, to which Blume gives the name of *Sapota Mülleri*, which yields a juice in every way equal to that of the Isonandra. It is probable that other trees of the same natural order may be found to yield a similar product. *Achras Sapota*, the fruit of which is known in the West Indies as Neesbery, also yields a milky juice like gutta percha. *Sapota Mülleri* of

Blume is probably the tree called "Bullet-tree" by the English, and its wood is known as "horse-flesh." It is a tall tree, yielding in summer a large quantity of milky juice. It appears that under the name of common Boerowe, or Bullet-tree, these have been confounded: 1, the *Lucuma mammosa* of Gærtner (Marmalade tree)—the Mimusops of Schomburgk; 2, the white Boerowe, which is the *Dipholis salicifolia* of Alph. D.C., and is known in Jamaica as Galimata; 3, the bastard Boerowe or Lowranero, which is the *Bumelia nigra* of Swartz; and 4, the Neesbery Bullet-tree, or *Achras Sideroxylon* of botanists, which yields one of the best of the Jamaica woods. *Sapota Mülleri* grows abundantly on slightly elevated situations. In collecting the milk the trunk is surrounded by a ring of clay, with elevated edges, and then an incision is made in the bark as far as the liber. The milky juice flows out immediately, and is collected in the clay reservoir. The juice resembles in some respects the milk of the cow. It forms a pellicle on its surface, which is renewed after removal. By the evaporation of the juice, we obtain 13 to 14 parts in 100 of pure gutta percha. This Surinam gutta percha is said to be sold at Amsterdam at the same price as the best gutta percha of commerce.—*Edinb. New Phil. Jour., April*, 1858.

4. *On Earthquakes in California during the year* 1857; by Dr. J. B. Trask, (Proc. California Acad. Nat. Sci., page 108, May, 1858).—During the past year there has been rather a frequency in the occurrence of the phenomena of earthquakes, and, with the exception of two, there have been none that were particularly remarkable either for extent of surface affected or severity of action. In one, that of the 9th of January, the greatest extent of surface, and greatest intensity of action was manifest. Its principal force seems to have been expended in the more southerly portions of our State, and in the immediate vicinity of those volcanic vents found at different localities upon the Colorado Desert. It is manifest, however, that this shock and those which preceded it on the night of the 8th, had their origin to the west of our coast, as the times of occurrence of the shock at different localities most fully prove. This matter was fully discussed in my previous paper, "On the direction and velocity of the Earthquake of January 9th, 1857," read before this Society March 30th, which will be found on page 98 of their Proceedings.*

The other shock of greatest extent, on the 2d of September, extended over an area of about 200 miles, but was marked by no particular severity or injury except that of fright to those who experienced it.

The whole number that can be authenticated as occurring during 1857, amounts to seventeen, being greater than the number recorded in 1853 and 1856, and it would seem probable from our records that this number is the maximum to which we shall probably be subjected in this State.

From the Sandwich Islands we have no news of earthquakes save one, which is here inserted: "A very severe shock of earthquake was felt at Kawaihae, Hawaii, on the 24th of February, the most severe that the residents there have had for many years."

The arrival of the whaling fleet from the northern seas brings no intelligence of the occurrence of these phenomena, as was the case of the preceding year, and hence, the presumption is, that subterranean action has not been violent in those distant regions during the year just passed.

* See this Journal, vol. xxv, 146.

On the coast of Mexico, over the region between the 25th and 32d parallels, we have received intelligence of the occurrence of one earthquake, which appears to have been felt on both shores of the gulf of California for a distance of nearly 200 miles, both north and south. We have no records south of that point.

The shocks which we can authenticate within the limits of our own State, are as follows:

Jan. 9: This shock was felt from Sacramento to the southern boundary of the State. It was preceded by three smart shocks the night and morning previous. The time of its occurrence at this city was $8^h\ 13^m\ 30^s$.—18th, 9 A. M.: A light shock at Martinez and Benicia.—20th, 8.30 A. M.: A smart shock was felt at Santa Cruz and Mission San Juan.—21st, 11 P. M.: On the evening of this day a smart shock was felt in Mariposa. The wave and sound seemed to travel from N. W. to S. E. It was accompanied with a report like that of a distant gun.

Feb. 5th, 7 P. M.: A smart shock was felt in San Francisco, which shook the buildings that are situated on made ground very severely, while those situated on firmer bottoms were less affected. This shock was felt at Oakland and Stockton, but was not felt at San José or Sacramento, as reported at the time.

March 14th, 3 P. M.: A severe shock was felt at Santa Barbara and Monticito. It was momentary in duration, attended with a loud report. —23d, 12.27 A. M.: A light shock in San Francisco.

May 3d, 10 P. M.: A smart shock at Los Angeles and the Monte.—23d: A light shock at Angeles; a report also that a severe shock had been felt at Fort Tejon.

June 14th: A shock was felt at Humboldt Bay. On the same day several severe shocks were experienced at the penal island, Carmen, Gulf of California, which extended almost ninety miles north and south of the island.

Aug. 8th, 11 A. M.: A smart shock was felt at Rabbit Creek, Sierra county.—29th: A severe shock at the Tejon Reserve. No time is given.

Sept. 2d, 7.45 P. M.: A light shock at San Francisco. This shock was felt at Sacramento, Marysville, Nevada, San Juan, Downieville and Camptonville.—14th, 2 P. M.: A light shock in San Francisco.

Oct. 19th, 6.30 P. M.: A severe shock of an earthquake in San Francisco. On the following morning, at 12.8 A. M., at 12.35 A. M., and 1.15 A. M., three other shocks occurred; the last, at 8 A. M., was equally severe with that of Jan. 9th. People were much frightened, and left their beds. The shock was felt at San José, but not at Oakland.

Nov. 8th, 3.45 A. M.: A shock at San Francisco, which was felt at Oakland and Bodega.

Dec. 23d, 7 A. M.: A light shock at San Francisco.

Of the whole number which have occurred during the year, two only have been felt at San Francisco that were not experienced at other localities, and four others have occurred which have been felt in common at other portions of the State; thus making about one-third of the whole number that were in common here and elsewhere.

Eight of the aggregate have occurred between the summer and winter solstices. Seven have occurred during the spring and summer months,

and ten during the winter and autumn. Eight have occurred between the vernal and autumnal equinoxes.

5. *The Connecticut Earthquake.*—On Tuesday night, the 30th of June, an earthquake was felt at New Haven and other places in its vicinity. At about 10¾ o'clock, P. M., a rumbling sound, similar to the passage of a carriage over a bridge, but more sonorous and more protracted in its movement, attracted the attention of many, besides a jar given to houses and the rattling of glasses. The movement was distinctly perceived to be traveling from southwest to northeast, and continued for something more than a minute. No damage was done to anything in the city of New Haven, nor, so far as we have been able to learn, in any portion of the State. The shock was felt in Bridgeport, Milford, Woodbridge, East Haven, and North Haven—all towns which lie in a southwest or northeast line from New Haven, and this fact may assist in determining its course. At the time of the shock the sky was clear and the air was perfectly still, though in that respect it did not materially differ from its general condition, in the centre of the city, through the evening. In Derby, the earthquake was felt, perhaps more sensibly than in New Haven. The houses, and even the large stone factories in Ansonia were shaken, and the watchmen alarmed by the movement of the earth.

6. *Reflections by the Clouds in the Catskills, near the Mountain House,* (from a letter to one of the editors).—There had been rain in the morning (July 31st) and also the night before, but it ceased in the afternoon, and we had all gone often to the piazza and to the windows to gaze on the *cloud-land* below us,—sometimes appearing like a wide plain of snow with banks and drifts,—sometimes suddenly opening just enough to disclose a house or field and then closing as suddenly. About half past six o'clock, P. M., as I joined again the assemblage on the rocks a little south of the hotel overlooking the valley, the valley appeared like one vast sea of mist or cloud nearly to our feet; grayish clouds were hovering over it in the south, and before me (east) I saw myself in a circular rainbow, brightening till a second pale inside circle surrounded the first, like a halo, but with a little amber-colored space between them. And what I saw of myself, each one saw of himself, and only of another when in close contact. As I moved my arms or head, the image moved; sometimes the circle deepened in tints, at others paled, as the sun shone brightly or was obscured by passing clouds. Shortly after, the sun went into a cloud and the vapors rolled away from the valley. But in a few minutes the valley and mountain side were again shrouded in heavy white clouds, and soon the sun again shone out; but it was so much nearer its setting, that when the vision reappeared it was thrown farther off, and was different in many respects. The reflection was not in a circle, but a long horizontal oval, and the rainbow tints were much paler; besides, the picture was not of an individual only, but of the group of two or three persons observing it, and of the irregular outline of the edge of the mountain precipice with the scattering wild plants growing on it. The first picture seen by us seemed as if nearly perpendicular on the cloud in front of us, which rose white and solid half way to the zenith with an arched outline; above and beyond and behind was clear sky, except the little flying clouds in the western horizon. M. S. J.

7. *Meteoric Stone of Borkut.*—This stone, according to Dr. Franz Leydolt (Sitz. Wien, xx, 398), fell on the 13th of October, 1852, at 3h P. M. at Borkut in Hungary. It was found two feet under ground, and still warm. The largest piece weighed 7 Vienna pounds and 6¼ loths, and the whole 12 pounds. The exterior is partly black or dull gray and much blebby or subscoriaceous, it being covered with a thin crust. The interior is ash-gray, and irregularly fine granular. Its specific gravity is 5·242. It afforded 18·26 p. c. of magnetic material, and 81·74 non-magnetic. The former was found to contain, Iron 85·14, nickel (with some cobalt) 10·06, copper and tin 0·40, sulphur 4·19, phosphorus 0·18 =99·97. Separating 11·53 as FeS^2 the composition of the iron corresponds to Iron 87·96, nickel 11·38, tin and copper 0·46, phosphorus 0·20.

The non-magnetic part was partly soluble in muriatic acid. The soluble and insoluble parts consisted of—

	S̈i	Ä̇l	Ḟe	Ċa	Ṁg	K̇	Ṅa
1. Soluble,	36·16	3·07	21·43	1·20	36·34	0·50	1·27
2. Insoluble,	57·29	4·20	12·08	3·90	17·67	1·14	3·72

The soluble part corresponds nearly to olivine; the insoluble to 34·93 p. c. oligoclase and 65·59 pyroxene. From these two analyses, there were excluded: from the *first*, before deducing the percentage, 0·82 sulphuret of iron, and 13·09 nickeliferous iron; from the *second*, 1·60 chromic iron.

8. *Geological Survey of Canada:* Sir W. E. Logan, F.R.S., Director. *Figures and Descriptions of Canadian Organic Remains*, Decade III. 102 pp., 8vo, with 11 plates.—This third Decade on the Organic Remains of Canada is the first yet issued. No. I is prepared by J. W. Salter, and nine out of the ten plates are already engraved. No. II is by James Hall of Albany, and will treat of Canadian Graptolites; there are to be sixteen plates, of which six are already engraved. This *third* number is by Mr. E. Billings, who has been appointed the palæontologist of the Survey, and treats of the Cystideæ, Star-fishes, and bivalve Crustaceans. It is a work of great merit, enlarging our knowledge of one of the obscurest departments of Palæontology. Besides Cystideæ and Star-fishes, a new genus called *Cyclocystoides*, containing discoid species of Echinoderms, is described by E. Billings and J. W. Salter.

It is remarkable that the Canadian Lower Silurian rocks have furnished twenty-one species of Cystideæ, while in New York only one has been found in the rocks of that age. We have not space for an abstract of the author's views on the Cystideæ and Crinoids. We only mention with regard to the latter that he gives reasons for holding, and apparently sufficient, that the ambulacral openings are at the base of the arms. This is a point which the abundant specimens in the western limestones would easily settle.

We are happy to add that copies of this Decade are on sale in the bookstore of B. Dawson & Son, Montreal, at a moderate price. It is too often the case in this country that the Reports, made under government orders on scientific subjects, are inaccessible to those who would value them.

A fourth Decade is in hand which will illustrate the Crinoids of the Canadian rocks.

8. *Gallerie Ausgezeichneter Naturforscher.* George André Lenoir publisher, Wien.—This "gallery of distinguished men of science" is a folio volume of one hundred lithographic plates, each containing a single portrait, and each portrait accompanied with a leaf of text. The few plates we have seen are engraved in the highest style of the art. The hundred portraits are led off by "Alexander Freiherr von Humboldt;" and following him there are three or more in each of the departments, Mathematics, Physics, Chemistry, Astronomy, Meteorology, Geography, Geology, Mineralogy, Botany, Zoology, Anatomy, and Physiology. Three of the names are American. The physicists included are: Amici, Baumgartner, Biot, Brewster, Ettingshausen, Faraday, Hansteen, Herschel, Jacobi, Magnus, Müller, Neumann, Plücker, Poggendorff, Pouillet, Weber, and Zantedeschi. This splendid work is to be issued at Vienna during the year.

9. *Obituary of William Scoresby;* by Dr. CHRISTISON, in his address to the Royal Society of Edinburgh, (from the Edinb. New Phil. Jour., [2], vol. vii, 314.)—The biography of WILLIAM SCORESBY* belongs not so much to us as to the parent Society of the sister kingdom. But as this remarkable man frequently visited us, joined us as an Ordinary Fellow, sometimes contributed to the business of our meetings, and was in early life a student of our University during the winter intervals of repose from his voyages of arctic adventure, it becomes me to advert shortly to the departure of one so eminent in science, so amiable in disposition, so distinguished for Christian virtue.

Scoresby was the son of an experienced whaler and able navigator of Whitby, in Yorkshire. The father's zeal in his profession was so intense and catholic, that he actually carried off his child to his favorite arctic regions at the age of ten, without the previous knowledge of Mrs. Scoresby —an attached wife, and no less fond a mother. The idea, it must be added, did not occur to the father till he one day detected, with much trouble, the urchin hidden below in the Resolution, while the "Blue Peter" was flying from the mast-head, and when the boy had a clear intention of running away from home in this remarkable manner. Entering thus early on a life of fearless adventure, it is no wonder that the second Scoresby outstripped the first in eminence as a navigator. At the age of sixteen, he discovered with his father an open polar sea near Spitzbergen, apparently stretching towards the North Pole; and he actually sailed in it to the latitude of 78° 46′—the highest known to have been ever attained up to that time. At the age of twenty-one he succeeded his father as commander of the Resolution whaler of Whitby; and for twelve years afterwards he annually fished the Greenland Seas, carrying on at the same time constant researches in geography, magnetism, geology, and zoology, for which he had prepared himself by several winters of study under Jameson and other Professors of the University of Edinburgh. The results were published in his "Account of the Arctic Regions," and in his "Voyage to the Northern Whale Fishery."

A deep, pure vein of piety, fostered by careful early training on the part of his parents, everywhere pervaded his pursuits, whether professional

* The death of Dr. Scoresby was announced in this Journal, in vol. xxiii, p. 448.

or scientific. No whale was hunted, and no other work that could be dispensed with was done by the crew of the Resolution on the Sabbath. Their captain was constantly as assiduous in maintaining the religious condition of his men as in preserving their health, and availing himself of their seamanship. But it is also recorded of him, that he generally contrived to reward the forbearance of his men, while their game was sporting securely on all sides around them on Sunday, by insuring that they should make prize of a whale or two at the first entrance of the hours upon Monday morning.

The depth and sincerity of his feelings as a responsible being he has recorded in his "Sabbaths in the Arctic Regions." The ultimate consequence of his following this bent of his mind was, that, while still in the prime of life and vigor, he deserted his favorite the sea, studied at Cambridge for the English Church, took, soon afterwards, the degree of Doctor of Divinity, and became a zealous and efficient member of the ministry, first among his co-mates as chaplain to the Mariner's Church at Liverpool, and eventually at Bradford, as pastor of an extensive manufacturing population.

The ardent and conscientious discharge of his religious duties, however, did not prevent him from applying also to the favorite scientific pursuits of his youth. Only a year before his death, indeed, he undertook a voyage to Australia, for the purpose of testing his theory respecting the aberration of the compass in iron ships; and one of his last scientific observations was the measurement of the ocean wave in a storm off the Cape of Good Hope, when he ascertained that the elevation of the highest, when the sea "ran mountains high," was forty feet from trough to crest.

I cannot, consistently with the indispensable brevity of this sketch, even so much as enumerate Dr. Scoresby's many contributions to science; but must now hasten at once to the close of this theme. Scoresby died, after a tedious illness, at a fair old age, in his sixty-eighth year. Few men can at that age console themselves with the retrospect of so long an existence so usefully spent. The intrepid seaman, the skillful navigator, the philosopher of no mean order, and the pious divine, was throughout his entire life full of good works in each and all of his multifarious vocations.

10. *Death of Bonpland.*—Aimé Bonpland, the eminent naturalist, died May, 1858, at San Borja, at the age of eighty-five. Bonpland was born at Rochelle in 1773. He was the son of a physician, and was brought up to his father's profession; but the political events of the early Republic compelled him to enter the navy. He made a long cruise as a naval surgeon, but took the earliest opportunity of returning to Paris to pursue his studies. There, at the house of Mr. Corvisart, he made the acquaintance of a young German of about his own age, who afterwards became known to the world as the celebrated Alexander von Humboldt. These young men became intimate friends, and when von Humboldt undertook his expedition to the equinoctial regions of the new world, Bonpland accompanied him. During this journey Bonpland collected and classed upwards of six thousand plants, which were then unknown to botanical writers. On his return to France he presented his collection to the Museum of Natural History, and received the thanks of Napoleon I., who granted him a pension. The Empress Josephine was very fond of Bonpland; she made him her factor at Malmaison, and often sowed in

her garden there flower-seeds which he had brought from the tropics. After the abdication at Fontainebleau, Bonpland urged the Emperor to retire to Mexico to observe events. A few weeks after tendering this fruitless advice, he sat by the death-bed of Josephine, and heard her last words. Her death and the definitive fall of the Empire, leaving him nothing to desire in France, he returned to South America, and became a professor of natural history at Buenos Ayres. Subsequently he travelled across the Pampas, the provinces of Santa Fé, Chaco, and Bolivia, and penetrated to the foot of the Andes. Being there taken for a spy, he was arrested by the Governor of Paraguay, and was detained a prisoner for eight years, till 1829. On his release he directed his steps towards the Brazils, and settled at San Borja, where, in a charming but humble retreat, surrounded by orange groves and shrubs, he remained to the day of his death, receiving with pleasure all French travellers who visited him. He was the author of many works, among which were *Les Plantes Equinoxiales*, (1805); *La Monographie des Mélastomées*, (1806); *Description des Plantes rares et de la Malmaison*, (1813); *Vue des Cordillères et Monuments Indigènes de l'Amerique*, (1819); and, jointly with von Humboldt, *Voyage aux Regions Equinoxiales du Nouveau Continent.*

We add the following letter from his early friend and companion, Baron von Humboldt (from the London Athenæum of July 24):

Aware of the deep sympathy felt for me by many of my friends, in my great distress at the death of my beloved, noble friend and travelling companion, Bonpland, I have considered it my duty to publish at any rate a short preliminary communication on the subject, for which I am indebted to the friendly zeal of Dr. Lallemant, (author of an important work on the diseases of Europeans in tropical climates). This accomplished man, thinking thereby to give me pleasure, after leaving the Imperial Austrian Expedition on board the frigate Novara, undertook a journey in February last from Rio Janeiro to Rio Grande, and from thence, by Porto Alegre and the former Jesuit Missions, to San Borja, where he erroneously supposed that Bonpland was still residing, as he had since the year 1831. I am in possession of two letters of Dr. Lallemant; one from San Borja, on the Uruguay, dated the 10th of April, another written from the Villa de Uruguaiana, on the 19th of April, 1858, after having conversed with Bonpland at Santa Anna:

"Whilst at San Borja," writes Dr. Lallemant, "I resided with an intimate friend of Bonpland, the Vicar Gay, in whose company I visited the formerly well-kept garden of the botanist, but which is now desolate and overgrown. Mr. Gay had received his last letter from Bonpland towards the end of the year 1857. Subsequently news was received of his serious illness. Letters written with a view to learn the state of his health remained unanswered, and in spite of the short distance it was still uncertain at San Borja whether I should find your travelling companion alive. Bonpland had left San Borja in the year 1853, to reside on his larger estate at Santa Anna, where he long occupied himself in cultivating orange trees of his own planting. The residence of the old man of science (in the Estancia of Santa Anna) consists of two large cottages, the mud walls of which are secured by bamboo poles and a few beams on the thatch. Both cottages have doors, but no windows, as the light is admitted by the

crevices between the bamboo supports of the wall. I was received in a hearty and friendly manner. In spite of the deep lines which a stirring life had imprinted upon the beloved countenance, the eye was still piercing, clear, and full of expression. Spirited conversation, commenced by himself, seemed to weary him much, and he suffered much from chronic rheumatism of the bladder. The privations which he so wonderfully imposes on himself are not in consequence of want or necessary retrenchment, but rather of long habit, great self-command, and characteristic individuality. The Government of Corrientes has presented him with an estate worth 10,000 Spanish piastres—he also enjoys a pension of 3,000 francs per annum from the French Government. He has always practised as a physician, with the most perfect disinterestedness. He is universally respected—greatly prefers, however, solitude, and especially avoids those who come to him for advice and assistance. His scientific zeal remains unabated; his collections and manuscripts are deposited at Corrientes, where he has founded a national museum. On the following morning I found him considerably weaker. The night had been a painful one. I earnestly entreated him to tell me if I could in any way be of service to him, but it was with me as with all his friends—'he was in need of no assistance.' I took leave of him with a sorrowful heart. How gladly would I have prevailed on him to return to the civilized world! But I felt with him, that his time was past. He belongs to the first period of the nineteenth century, not to the second. It appeared to me that your friend was himself affected when I took both his wrinkled hands in mine to bid him adieu. Those who surround him have found his powers failing him much during the last three months. Perhaps the old man experienced the same feelings at parting as myself, who would probably be the last messenger of European birth sent to him from afar off into this wilderness, to express to him, in the name of science, all the reverence, love, and thankfulness which is due to him. I mounted my horse and galloped in a northern direction, across the green plains. No path directed me; I was disturbed by no guide; I was alone with my mournful thoughts on Bonpland sinking into the grave."

How happy was the last letter which I received from Bonpland, from Corrientes, dated the 7th of June, 1857:

"J'irai," said he, "porter mes collections et mes manuscrits moi-même à Paris, pour les déposer au Muséum. Mon voyage en France ne sera que trés court; je retournerai á mon S. Ana, où je passe une vie tranquille et heureuse. C'est là que je veux mourir, et où mon tombeau se trouvera à l'ombre des arbres nombreux que j'ai plantés. Que je serais heureux, cher Humboldt, de te revoir encore une fois et de renouveler nos souvenirs communs. Le mois d'août prochain, le 28, je compléterai ma 84éme année, et j'ai trois (4) ans de moins que toi. Il vient de mourir das cette province un homme de 107 ans. Quelle perspective pour deux voyageurs qui ont passé leur 80éme anné."

This joyous letter, almost expressing a longing for life, contrasts wonderfully with the mournful description of Dr. Lallemant's visit. In Monte Video (according to Mr. von Tschudi) it was believed that Bonpland had died at San Borja, on the 29th of May, but without further particulars. On the 18th of April Lallemant conversed with him at Santa Anna. On

the 10th of May his death was denied at Porto Alegre. There is, therefore, still hope that the younger of the two has not been the first summoned away. At such great distances, uncertainty is often unfortunately long continued,—as evidence, the anxiety on account of Edward Vogel in Central Africa and Adolph Schlagintweit in Central Asia.

Berlin, 12th July, 1858.

Track Survey of the River Parana, surveyed by Commander THOMAS J. PAGE, U. S. S. Water Witch in 1855. Sheets Nos. 3, 4, 5, 6, 7.

DE LA RIVE: Treatise on Electricity, translated for the author by C. V. Walker, F.R.S. *London.* Vol. I (18*s.*) and II (28*s.*), have been published.

HUMBOLDT'S Cosmos, translated by Major General E. SABINE. Vol. IV, part I. *London*, 1858.

J. GLAISHER: Stereoscopic Magazine, a gallery of English and foreign landscape scenery, architecture, antiquities, and natural history, and accompanied with descriptive letter-press by writers of eminence, in their respective departments. The first number issued in London, July 1st; price 2*s.* 6*d.*

Professor POGGENDORFF, of Berlin: Biograph. literar. Handwörterbuch zur Geschichte der exacten Wissenschaften. *Leipzig.* J. A. Barth. This work is a Scientific Biographical Dictionary, giving briefly the time and place of birth and death, profession and principal publications of men of science, both living and dead. The part issued goes half through the letter D. It is prepared with great care, and will be a valuable book of reference.

ALCIDE D'ORBIGNY: Histoire Naturelle des Crinoides, vivants et fossiles, in 4to, with eighteen plates, containing 300 figures. *Paris*, J. B. Bailliere, et fils. 12*fr.*

LACÉPÉDE: Hist. Naturelle comprenant les Cétacés, les Quadupèdes ovipares, les Serpents, et les Poissons. New edition, preceded by a eulogy of Lacépéde by Cuvier, and with notes and the new classification of A. G. Desmarets. 8vo, vol. I. *Paris*, 1857.

O. G. COSTA: Ittiologia fossile Italiana (Fossil Italian Ichthyology.) intended as a supplement to Agassiz's work on Fossil Fishes. pp. 1—40, 4to, with three colored plates. *Naples*, 1855–'56.

COTTEAU & TRIGER: Echinides du Département de la Sarthe. 1st Livr., 8vo, 48 pages, with plates. *Paris*, 1857.

G. NICOLUCCI: Delle razze humane, (the Human Races). Vol. I, Fasc. I. viii. and 176 pp., 8vo. *Naples*, 1857.

Dr. C. RITTER: Die Erdkunde im Verhaltniss zur Natur und zur Geschichte des Menschen, &c.; 18th part, 3d book. Asia Minor. 1 vol., 8vo. *Berlin.* $4.13.

A. D'ARCHIAC: Histoire des Progrès de Geologie, Tom. VII, Jurassic Formation, 2d part, 718 pp., 8vo. *Paris*, 1857.

H. v. MEYER: Reptilien aus der Steinkohlen Formation in Deutschland, x and 127 pages, fol., with sixteen plates. *Cassel*, 1858. 27⅓*ngr.*

C. L. BONAPARTE: Iconographie des Pigeons non figurés par Mme. Knip dans les deux volumes de MM. Temminck et Prevost. Livr. 2—7 fol. *Paris*, 1858.

A. LADREY: Chimie appliquée à la Viticulture et à l'Œnologie; 600 pages, 12mo. *Paris*, 1858. 7*fr.*